

# Contents—Aug. 1945

Volume XXVI

No. 8

## ARCHIVES OF PHYSICAL MEDICINE

(Formerly Archives of Physical Therapy)

30 North Michigan Avenue, Chicago 2, Illinois

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Subscription — In the United States, its possessions, and Mexico, \$5.00 yearly; Canada, \$5.50; elsewhere, \$6.50 the year. Advertising rates on application. All advertising copy subject to acceptance by publication committee. Published monthly at Chicago, Illinois, by American Congress of Physical Medicine. Entered as Second Class Matter, February 15, 1945, at the Post Office at Chicago, Illinois, under the Act of March 3, 1879.

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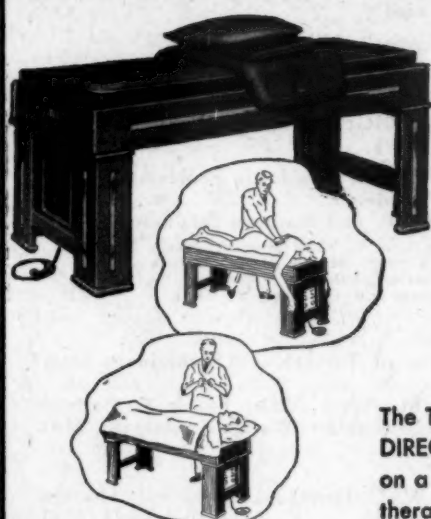
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# POLIOMYELITIS \*

## Differential Diagnostic Problems Encountered in an Epidemic

A. THEODORE STEEGMANN, M.D.

and

KATHRYN STEPHENSON, M.D.

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This paper is a report on the differential diagnostic problems encountered in an epidemic of acute anterior poliomyelitis which occurred in Kansas during the summer and fall of 1943. During that period 121 patients suspected of having the disease were admitted to the University of Kansas Hospitals for diagnosis and treatment. Except for a few from Missouri, the patients were sent in from twenty-five counties scattered throughout the state of Kansas. It soon became apparent that an important part of the task was to establish an accurate diagnosis and to weed out patients suffering from some disease other than acute anterior poliomyelitis.

Of the 121 patients, 90 were considered to have acute anterior poliomyelitis (table 1). These 90 patients were classified as having "paralytic"

TABLE 1. — *Classification of Cases.*

Diagnosis	Number of Cases	Percentage of Total Cases	Percentage of Cases of Poliomyelitis
Poliomyelitis suspected .....	121	100	—
Acute anterior poliomyelitis.....	90	74.4	100
Paralytic .....	44	—	48.9
Nonparalytic .....	46	—	51.1
Cranial involvement .....	28	—	31.1
Mesencephalic .....	8	—	8.9
Bulbar .....	20	—	22.2
Death from bulbar paralysis.....	11	—	12.2
Cases differentiated from poliomyelitis.....	31	25.6	—

or "nonparalytic" forms of the disease. A classification of "paralytic" required the presence of paralytic symptoms twenty-one days after the onset of paralysis. Of the 90 patients, 28 were classified as having cranial involvement; that is, the disease manifested itself by the involvement of structures supplied by the cranial nerves. In most of these the disease was of the bulbar type, and the 11 deaths in the series resulted from bulbar paralysis. Attention should be called to the large number of patients with nonparalytic poliomyelitis (51.1 per cent). Some of these had bulbar involvement but recovered promptly and were not classified with the paralytic group. The dangerous implications of bulbar paralysis are indicated by the large percentage of deaths.

All of the patients were treated by the Kenny method under direction of the department of physical therapy. This method of relieving muscle spasm is based on sound physiologic principles, but a high percentage of recovery among the patients with nonparalytic poliomyelitis could be expected without it. Patients classified as having a nonparalytic form should not be included to boost the percentage of "good results" in the evaluation of results by the Kenny technic. It is not the purpose of this paper to deal with that problem.

\* From the Departments of Neurology and Pediatrics, University of Kansas School of Medicine.

\* Read at the Twenty-Third Annual Session of the American Congress of Physical Medicine, Cleveland, Sept. 8, 1944.



A diagnosis of acute anterior poliomyelitis can be made with reasonable certainty when all four of the following criteria can be met:

1. A history of fever, headache, malaise and sore throat associated with nausea, vomiting and diarrhea or constipation for a period of one to seven days.

2. The presence on physical examination of nuchal rigidity or spasm of the neck, back and hamstring muscles.

3. The development or evidence of muscular weakness, usually in asymmetric muscle groups, associated with reduced deep reflexes and mild rigidity on passive movement. There may be tenderness over nerve trunks or muscles.

4. Changes in the spinal fluid, particularly pleocytosis, with a count up to a few hundred cells per cubic millimeter. There is a mild increase of the total protein, with a normal dextrose and chloride content and an absence of micro-organisms.

Merritt and Fremont-Smith<sup>1</sup> found that the highest white cell count occurs in the preparalytic stage, with the cells predominately of the polymorphonuclear type. The cell count falls rapidly, with a shift toward predominance of the lymphocytic type of cell after the onset of paralysis. There is no relationship between the spinal fluid changes and the degree and site of the paralysis. Cases 1, 2 and 3 illustrate these diagnostic criteria. Unless the poliomyelitis virus is isolated by a known technic<sup>2</sup> the diagnosis cannot be made with more certainty.

The certainty of the diagnosis is diminished when muscular weakness or paralysis is absent. It frequently happens that two children of a family are stricken with the disease. In one child paralysis may develop, and his case may meet all of the other criteria; the case of the other child may meet all of the criteria except muscular weakness. That both children have poliomyelitis can hardly be questioned. During the epidemic many patients were seen in whom paralysis never developed, but who, in view of the other criteria, were considered to have poliomyelitis.

There are three groups of patients for whom the diagnosis is uncertain. The first group, already mentioned, show premonitory symptoms of fever, headache, sore throat or perhaps gastrointestinal symptoms. Nuchal rigidity or muscle spasm of the neck and back muscles develops but does not go on to paralysis. These patients always have characteristic spinal fluid changes, and without such changes the diagnosis of poliomyelitis should not be made. Case 4 presents a good example.

The second group of patients are those with paralytic signs in whom the initial illness is indefinite or has subsided before admission to the hospital. The type, degree and duration of the paralysis is important. The spinal fluid examination may not confirm the diagnosis if the paralysis has been present for a few weeks, because not only have the cells in that period shifted to the lymphocyte type, but the count may have become reduced to normal or only slightly above normal. A careful neurologic examination is very important in such cases. It should not be necessary to emphasize the importance of performing a spinal puncture with careful and complete study of the spinal fluid in all such cases. The patients in cases 5 and 6 belong to this group.

Patients of the third group, rarely encountered, have bulbar paralysis but the disease does not meet the criteria of acute poliomyelitis and the patients die too soon after admission for complete studies to be made. As a

1. Merritt, H. Houston, and Fremont-Smith, Frank: *The Cerebrospinal Fluid*, Philadelphia, W. B. Saunders Co., 1938, p. 130.

2. Paul, J. A.; Trask, J. D., and Cullota, C. S.: *Poliomyelitic Virus in Sewage*, *Science* 90:258 (Sept. 18) 1939.



rule patients with bulbar paralysis offer no difficulty in diagnosis. Case 7 is an exception. The paralysis was similar to that observed in other cases of bulbar poliomyelitis, but there was no evidence of fever, leukocytosis or spinal fluid changes. There was a rapid extension of the paralysis to the thoracic muscles, resulting in respiratory failure and death. The autopsy failed to explain the causation. The possibility of diphtheria as a cause of bulbar paralysis must not be overlooked. In diphtheria the spinal fluid may contain an increased amount of protein but there is no pleocytosis.<sup>3</sup> Fatal bulbar poliomyelitis also occurred in a boy of 17 who became ill in a military school in Missouri. At the same time several other boys became ill with similar symptoms. Botulism was considered as a possible diagnosis. Clinically the picture was typical of acute poliomyelitis. The patient had a leukocyte count of 18,500 on admission. The spinal fluid contained 150 cells; the total protein content was 86 mg., the sugar content 86 mg. and the chloride content 754 mg. per hundred cubic centimeters, and the colloidal gold curve read 0011111100.

The cases that had to be differentiated from acute anterior poliomyelitis are tabulated in table 2. In half of these the diagnosis was infection of the

TABLE 2. — Cases Differentiated from Poliomyelitis.

Diagnosis	Number of Cases	Percentage of the 31 Cases	Comment
Infection of upper respiratory tract .....	9	29.0	
Acute pharyngitis .....	1	.....	Hemolytic streptococcus
Nasopharyngitis .....	1	.....	
Acute follicular tonsillitis .....	2	.....	
Acute sinusitis .....	2	.....	
Common cold .....	1	.....	
Common cold and diarrhea .....	1	.....	
Unclassified .....	1	.....	
Gastrointestinal infection .....	7	22.6	
Gastroenteritis .....	1	.....	Causation?
Diarrhea .....	3	.....	Causation?
Typhoid fever .....	2	.....	
Impacted feces .....	1	.....	
Peripheral neuropathy .....	2	6.4	Both, infective neuronitis
Poliomyelitis suspected because of nuchal rigidity, muscle pain or spasm .....	7	22.6	
Acute rheumatic fever .....	1	.....	
Influenzal pneumonia .....	1	.....	
Miliary tuberculosis .....	1	.....	
Osteomyelitis .....	1	.....	Pain in right thigh; delayed roentgen ray evidence
Pyelitis .....	1	.....	Pain in lumbar muscles
Pain in arms .....	1	.....	Patient afebrile; causation?
Pain in legs .....	1	.....	Undiagnosed febrile illness
Poliomyelitis suspected because of motor symptoms .....	6	19.4	
Hysteria .....	4	.....	
Congenital anomaly of neck of femur .....	1	.....	
Foot drop .....	1	.....	Undiagnosed disease

upper respiratory or gastrointestinal tract. Both types of symptoms were present in some cases (case 8). Because both types of symptoms occur in the initial stage of acute poliomyelitis it is not difficult to understand why persons showing them are suspected of having a beginning poliomyelitis during an epidemic. It is perhaps safer for clinicians during the poliomyelitis season to consider all patients, especially children, who have fever as-

3. Merritt and Fremont-Smith,<sup>1</sup> page 182.

sociated with upper respiratory or gastrointestinal symptoms as possibly having poliomyelitis until it is proved that they have not. This is particularly true when there is evidence of rigidity or pain on flexing of the neck and back muscles. Some patients with these symptoms recover so rapidly after therapy is instituted that poliomyelitis can easily be excluded (case 8). Sometimes examination of the spinal fluid offers the most reliable means of excluding poliomyelitis. The pain and rigidity of the neck muscles are caused by meningism. This occurs at the onset of many acute infections and is believed to be caused by an increased production of spinal fluid. Merritt and Fremont-Smith<sup>4</sup> stated that a disturbance of equilibrium occurs between the blood and cerebrospinal fluid. At the onset of any acute infection there is a rapid dilution of the blood, which makes it relatively hypotonic to the cerebrospinal fluid, with a subsequent greater filtration through the choroid plexus, and an increase in the cerebrospinal fluid pressure. The chloride content of the cerebrospinal fluid is decreased, since the fluid is formed from blood serum that has a decreased chloride content. The protein content of the cerebrospinal fluid drops but the value for sugar is unaltered. The cell count is normal. These spinal fluid changes differentiate meningism from poliomyelitis. In cases 8 and 9 the diagnosis was infection of the upper respiratory tract.

The group of cases in which there were gastrointestinal symptoms were comparable to those in which there was infection of the upper respiratory tract. Cases 10 and 11 were classified in that group. In case 11 a mild bulbar poliomyelitis could not be definitely excluded. The 2 patients with typhoid fever, one of whom died the day after admission, would not ordinarily have been thought to have poliomyelitis. One had been treated before admission for "meningitis" and then sent to the hospital with a diagnosis of poliomyelitis. Many neurologic complications occur in typhoid fever<sup>5</sup> and frequently lead to confusion before the etiologic factor is confirmed.

The 2 cases in which the diagnosis was peripheral neuropathy (table 2) were both cases of infective neuronitis.<sup>6</sup> This disease is frequently confused with acute anterior poliomyelitis. This fact has been emphasized recently by Sahs and Paul.<sup>7</sup> Case 12 is a typical example. This case illustrates some clinical facts frequently described in the literature.<sup>8</sup> In approximately a third of the cases the initial illness is followed by an interval of apparent health before the onset of paralytic symptoms. In this case the sensory changes were not marked and were hardly recognized by the patient although they were definite on neurologic examination. The motor changes consisted of a peripheral, symmetrical flaccid weakness, not segmental and asymmetric as in poliomyelitis. The onset of the motor symptoms is less abrupt, and they do not have the global character seen in poliomyelitis. They tend to be slowly progressive. Occasionally the proximal muscle group is more severely involved than the distal musculature. The lower extremities are frequently most severely involved, as in case 12. The tendon reflexes are soon abolished, but the cutaneous reflexes are generally preserved. Involvement of the facial and other cranial nerves may occur. There was mild weakness of the palate early in the disease in case 12. Diphtheric paralysis

4. Merritt and Fremont-Smith,<sup>1</sup> page 190.

5. Wilson, S. A. Kinnier, and Bruce, A. Ninlan: *Neurology*, Baltimore, Williams & Wilkins Company, 1940, vol. 1, p. 68.

6. This is also called Acute Infectious Polyneuritis, Acute Febrile Polyneuritis, Radiculoneuritis with Albuminocytologic Dissociation (the Guillain-Barré Syndrome), Facial Diplegia in Multiple Neuritis, etc.

7. Sahs, A. L., and Paul, W. D.: *Neuronitis-Differentiation from Poliomyelitis*, *Arch. Phys. Therapy* 29:395 (July) 1948.

8. Guillain, Georges: *Radiculoneuritis with Acellular Hyperalbuminosis of the Cerebrospinal Fluid*, *Arch. Neurol. & Psychiat.* 36:975 (Nov.) 1936. McIntyre, Howard D.: *Infective Neuronitis*, *Ohio Stat. M. J.* 33:875 (Aug.) 1937. Fox, M. J., and O'Connor, R. D.: *Infectious Neuronitis*, *Arch. Int. Med.* 69:158 (Jan.) 1942. Jones, J. Albright; Holmes, John W., and Weinstein, Mary: *Acute Infectious Polyneuritis (Guillain-Barré Syndrome)*, *Am. J. M. Sc.* 266:205 (Sept.) 1943.

must be excluded, because in both diseases there may be elevation of the spinal fluid proteins without pleocytosis. This feature is important in the differential diagnosis between poliomyelitis and infective neuronitis. Most observers do not believe that the spinal fluid protein has to reach the high level (i. e. 300 mg. per hundred cubic centimeters or above) emphasized by Guillain to confirm the diagnosis. A recurrence of symptoms or the development of paralysis in new muscle groups after the patient is thought to be on the way to recovery occurs frequently but has not been emphasized in the literature. Guillain has pointed out that the prognosis is favorable even after severe paralysis. This clinical feature is so striking that cases of severe paralysis diagnosed as "poliomyelitis" in which the patient makes a complete recovery are probably cases of infective neuronitis which has not been recognized. On the other hand, death may occur in severe cases of neuronitis. The characteristics of infective neuronitis are nonseasonal occurrence, absence of severe initial illness and absence of nuchal rigidity or muscle spasm. The interval between the initial illness and the onset of paralysis has been emphasized as a distinguishing characteristic. This has not been our experience. Most frequently during the epidemic of poliomyelitis the patient suffered an initial illness of two or three days followed by a period of five to seven days before the onset of the symptoms diagnostic of acute anterior poliomyelitis. Many patients had fever, vomiting and malaise for forty-four to seventy-two hours followed by a period of apparent well-being. In infective neuronitis the total protein content of the cerebrospinal fluid may continue to rise several weeks after the onset of the disease even when the clinical manifestations of paralysis are disappearing (case 12). In poliomyelitis the total protein content of the cerebrospinal fluid does not reach as high a level or persist as long as in infective neuronitis.

The second case of infective neuronitis seen during the epidemic is of interest because of a recurrence of paralysis. The patient was a 13 year old girl admitted Oct. 17, 1943 with weakness and loss of reflexes in her lower extremities. Her symptoms had been present since the latter part of June, and a diagnosis of poliomyelitis was made before admission. The absence of sensory changes pointed toward a residual poliomyelitis, although the degree of muscular atrophy was not comparable to the degree of muscular weakness present. An important error of omission was the failure to examine the spinal fluid. She was treated by the Kenny method, made a remarkable recovery and was discharged Jan. 8, 1944. About the middle of May she began to experience a recurrence of weakness in the lower extremities and fell frequently. Her condition became progressively worse, and weakness in the hands became noticeable. Some numbness of the hands and feet also developed. The patient was readmitted to the hospital June 17 and is still under treatment. At present the clinical picture is typical of peripheral polyneuropathy. Signs of recovery have been present since August. Early in July she was unable to stand, walk or feed herself. The spinal fluid on June 19 contained no cells but had a total protein content of 102 mg. per hundred cubic centimeters. It was otherwise normal. On July 7 it contained 2 white cells and 282 mg. of total protein. The correct diagnosis could probably have been made at the time of her first admission by a spinal puncture and a good many weeks of Kenny treatment obviated.

The remainder of the cases differentiated from acute poliomyelitis (table 2) represent various diagnoses and symptoms. Their analysis must answer the question: Why was poliomyelitis suspected in these cases? A survey of the histories reveals that in all of these cases there was present one of the two symptoms typical of acute poliomyelitis exclusive of fever, head-



ache and other signs of infection. In the first group poliomyelitis was suspected because of nuchal rigidity, muscle pain or spasm; in the second group, because of the development of motor symptoms.

There were 7 cases in the first group. In those in which the diagnosis was, respectively, acute rheumatic fever, osteomyelitis and pyelitis, there was muscular pain. Meningism occurred in the case of influenzal pneumonia and in the case of miliary tuberculosis. In the remaining 2 cases there was muscular pain in the extremities but an etiologic factor was not discovered. Exclusion of poliomyelitis was made possible by the discovery of clinical or laboratory evidence of the disease diagnosed and by the absence of the spinal fluid changes seen in poliomyelitis.

In the remaining 6 cases poliomyelitis was suspected because of the development of motor disturbance. During the epidemic newspaper publicity probably contributes to the development of motor disorders of hysterical origin in suggestible persons. Such disorders were easily detected because of the nonanatomic type of sensory change, the tendency to exaggerate, the paralysis unassociated with changes in muscle tone or reflexes, the absence of true muscle spasm and the normal spinal fluid. Four such cases were observed. Emotional reactions and suggestibility are not always evident in a well developed conversion neurosis. One of the patients was a young woman who had been treated by the Kenny method for poliomyelitis in another hospital. She improved and was sent home but had new symptoms within a week. Multiple sclerosis was considered in the differential diagnosis. Case 13 is another example.

One patient with motor symptoms was a 14 month old child who began to limp with the left leg seven days prior to admission. Examination of the spinal fluid by a local physician the day before admission was reported as giving normal results. A roentgenogram revealed an unsuspected congenital anomaly of the neck of the femur.

A 3 year old child in whom a left foot drop developed the day before admission showed pain on extension of the left leg. The causation was not discovered. Poliomyelitis was excluded by the absence of clinical and laboratory evidence.

In the cases discussed in this paper, poliomyelitis would probably not have been considered in the diagnosis except during an epidemic. During an epidemic the criteria described for the accurate diagnosis of acute anterior poliomyelitis or polioencephalitis of the Heine-Medin type must be rigidly adhered to in order to exclude a wide variety of infections and other diseases.

### Report of Cases

CASE 1. — T. J., a boy aged 6, was admitted August 1 and dismissed August 28, 1943. He had been nauseated and feverish for four days prior to admission. Two days before he had complained of pain in the stomach, and at this time had vomited. The day before admission he was unable to walk without stumbling. A physician was called and hospitalization advised.

Physical examination disclosed that the temperature was 101 F. The patient appeared slightly feverish but not acutely ill. The pharynx was injected. The neck showed slight adenopathy, and flexion was painful. Neuromuscular examination revealed considerable weakness of the left leg, which the patient was unable to lift without assistance. The biceps and triceps reflexes were hyperactive; the abdominal, patellar and Babinski reflexes were absent.

Examination of the urine showed rare pus cells and numerous bacteria. The blood contained 81 per cent hemoglobin and 7,250 white cells. Examination of the spinal fluid disclosed an initial pressure of 250 mm. of spinal fluid and a final pressure of 210. The sugar content was 63.4, the sodium chloride content 675 and the protein content 4.9 mg. per hundred cubic centimeters. There were 49 white blood cells per cubic millimeter and

no red blood cells; the differential count was 44 per cent lymphocytes and 56 per cent polymorphonuclear cells.

The patient was given routine treatment. On the third day after admission he was afebrile, and he remained so throughout his stay in the hospital. He responded slowly, but regained the use of the right leg, which had been weak on admission. He received muscle reeducation during the last two weeks of his stay in the hospital. The muscle group in the left leg responded, but there remained considerable weakness.

The diagnosis was acute anterior poliomyelitis, paralytic type.

CASE 2. — D. W., a girl aged 6 years, was admitted August 6 and died August 9, 1943. Her chief complaint on admission was inability to swallow. Two weeks prior to admission she had been swimming, and after this exercise a headache and fever had developed. These symptoms cleared up, and she was well until four days prior to admission, when she again had fever and anorexia. Sulfathiazole was given, without relief, and the day before admission the patient vomited, was constipated and had a temperature of 101 F. About noon on the day of admission there was inability to swallow and her physician recognized that hospitalization was necessary.

Physical examination revealed that the child was irritable and had a temperature of 102 F. She was unable to swallow. Otherwise examination of the ears, nose and throat gave normal results. The chest was clear, and the heart rate was rapid, but no abnormalities were noted. Neurologic examination revealed extreme rigidity of the neck but no limitation in the function of the extremities, although marked muscular spasm was present throughout the body. The patient had considerable difficulty in swallowing. The patellar and biceps reflexes were hypoactive.

Examination of the urine showed 1 plus reaction for albumin, 10 to 15 pus cells and 5 to 6 red blood cells per high power field. Examination of the blood at the time of admission showed 90 per cent hemoglobin and 14,600 white cells. The blood sugar content on August 9 was 57 mg. per hundred cubic centimeters. The spinal fluid at the time of admission contained 50 red blood cells per cubic millimeter and 70 white blood cells, with 63 per cent polymorphonuclear cells and 37 per cent lymphocytes, and the colloidal gold curve showed one point elevation in the first four tubes. The sugar content of the spinal fluid was 116, the sodium chloride content 750 and the total protein content 26 mg. per hundred cubic centimeters.

The patient on admission was given 500 cc. of 5 per cent dextrose in physiologic solution of sodium chloride by proctoclysis and thereafter received 500 cc. twice daily. Continuous packs were applied to her neck and shoulders. Respiration became increasingly difficult. Aspiration and administration of oxygen were both necessary. Because of the patient's rising temperature, which was 102 F. on admission and the following day was 105 F., the amount of the dextrose solution administered parenterally was increased to 1,000 cc. Despite the therapy, death occurred on the third day of hospitalization.

The diagnosis was poliomyelitis, bulbar type.

CASE 3. — J. R., a boy aged 13, was admitted August 19 and was discharged September 4, 1943. For four days prior to admission he had suffered from fever accompanied by stiffness and soreness of the neck. He was given sulfathiazole treatment. Three days before admission his temperature rose to 105 F., and the following day diplopia developed. The stiffness of the neck persisted, and the day before admission he was unable to swallow fluids without some difficulty.

At the time of admission physical examination revealed that the boy was extremely excitable. His temperature was 100 F. Paralysis of the soft palate was present. There were also ptosis of the right eyelid, some stiffness of the neck and weakness of the arms. The rectus abdominis muscles were in spasm, and the muscles of the back were rigid. He was unable to elevate his legs above 30 degrees without pain. The Babinski reflex was present, the patellar and abdominal reflexes hypoactive and the cremasteric reflex absent. No other abnormalities were discovered.

The urine was found to contain many bacteria and 1 to 3 pus cells per high power field. The blood contained 7,950 white cells per cubic millimeter and 92 per cent hemoglobin. The spinal fluid contained 150 white cells, 54 per cent polymorphonuclear cells and 46 per cent lymphocytes. The colloidal gold curve had a one point elevation in the first four tubes. The sugar content of the spinal fluid was 64, the sodium chloride content 775 and the total protein content 42.3 mg. per hundred cubic centimeters.

The patient was given routine treatment. The day after admission he was able to swallow and was placed on a high caloric diet. His neck continued to be stiff, and there was some inability to use his neck muscles. The ptosis of his left eyelid persisted. On the third day his temperature was normal and the diplopia and ptosis had disappeared. The right side of the soft palate continued to deviate to the left, and the sternocleidomastoid muscles were weak. He gradually recovered power in his arms and increased use of the neck muscles. At the time of discharge he was able to elevate his legs to a

90 degree angle without pain but continued to show paresis and incoordination of the sternocleidomastoid muscles. He was discharged improved.

The diagnosis was acute anterior poliomyelitis, bulbar and mild paralytic type.

CASE 4. — J. A. S., a girl aged 4, was admitted August 30 and dismissed September 9, 1943. One week prior to admission she had become ill with headache and fever. On the same day stiffness of the neck developed.

Physical examination revealed the child to be well nourished, well developed and somewhat apprehensive. Her temperature was 101.8 F. She did not appear to be acutely ill. Her ears, eyes, nose and throat were essentially normal. The chest was clear. The heart revealed no thrill or murmur. On abdominal examination there were no palpable viscera and no tenderness. The neuromuscular examination showed some spasm in the trapezius and rhomboid muscles, the posterior neck muscles and the quadriceps. The neurologic examination revealed some nuchal rigidity. The abdominal reflexes were hyperactive, the patellar reflexes hypoactive and the Babinski absent.

An examination of the urine showed 2 to 5 red blood cells and occasional pus cells per high power field. The blood contained 13,550 white blood cells and 84 per cent hemoglobin. Examination of the spinal fluid disclosed 50 white blood cells per cubic millimeter, with 63 per cent lymphocytes and 37 per cent polymorphonuclear cells. The colloidal gold curve showed one point elevation in the first four tubes. The spinal fluid sugar content was 87.2 mg., the sodium chloride content 750 mg. and the total protein content 47.6 mg. per hundred cubic centimeters.

The patient on admission was given routine care. On the second day of hospitalization her temperature was within normal limits, and it remained so thereafter. She was dismissed with no evidence of muscle weakness.

The diagnosis was acute anterior poliomyelitis.

CASE 5. — C. J. D., a girl aged 2, was admitted September 21 and was discharged September 22, 1943. Ten days before admission she began to have a fever and seemed to be somewhat dizzy. She experienced some difficulty in walking at this time and continued to do so for four or five days. Thereafter she apparently regained her normal health. Two days before admission, her father noticed that her eyes had begun to converge. This was an alternating type of strabismus and progressively increased in the twenty-four hours before admission. She had had some difficulty in walking during the same period. Two days prior to the child's admission the mother had been admitted to this hospital with a definite diagnosis of poliomyelitis.

On physical examination the child showed no gross abnormalities aside from the alternating internal strabismus, which was more persistent on the left. The neurologic examination revealed the knee jerks to be more active on the left than on the right. There were no pathologic reflexes.

The blood contained 77 per cent hemoglobin and 5,850 white cells per cubic millimeter. Examination of the spinal fluid disclosed 15 red blood cells and 2 white blood cells per cubic millimeter. The colloidal gold curve showed one point elevation in the first five tubes.

The patient was in the hospital for about twelve hours. The father was uncooperative and felt that the child should not be hospitalized. He would not comply with the hospital rules. The child was released.

The diagnosis was poliomyelitis involving the rectus lateralis muscles, the left especially.

CASE 6. — A. F., a woman aged 25, was admitted to this hospital September 23 and dismissed October 3, 1943. She had been delivered of a full term baby in St. Luke's Hospital ten days prior to admission to the University of Kansas Hospitals. Her labor had been difficult and had lasted more than twenty-four hours. After delivery she complained of pain in her legs, especially on the right, and also pain in her back and neck. The following day she was unable to lift her left leg, and on the day of admission there was considerable limitation of motion in her right leg.

On physical examination the patient was found to have a temperature of 99.6 F. Her neck showed some resistance. She was unable to move her left leg except to wiggle her toes. Voluntary activity was also absent in the right leg. On elevation of the left leg above an angle of 20 degrees pain was experienced, but the right leg could be elevated to 60 degrees without pain. Neurologic examination revealed equal and active biceps reflexes. The patellar reflex was absent on the left but hyperactive on the right.

The urine showed a 1 plus reaction for albumin. It was loaded with pus clumps and red blood cells. The reaction to the benzidine test was 4 plus. The blood contained 81 per cent hemoglobin and 8,050 white blood cells per cubic millimeter. The blood sugar content was 57, the sodium chloride 725 and the protein 185 mg. per hundred cubic centimeters. Examination of the spinal fluid disclosed no red blood cells and 14 white blood cells per cubic millimeter, with 7 per cent polymorphonuclear cells and 93 per cent lymphocytes. The colloidal gold curve showed one point elevation in the first seven tubes.

The patient received routine treatment and was afebrile throughout her stay. She



was transferred to St. Luke's Hospital for further care. There was no noticeable improvement in her condition.

The diagnosis was acute anterior poliomyelitis, involving the muscles generally.

CASE 7. — R. F., a man aged 43, was admitted October 20 and died October 22, 1943. He was admitted as an emergency patient because he was unable to speak or swallow. By using his fingers he did indicate that he had been sick for five or six days prior to admission. There were no accompanying friends to give a history.

On physical examination the patient was found to be well developed and well nourished. His pharynx was somewhat diffusely reddened. The soft palate deviated to the left. The gag reflex was absent. Examination of the chest showed no alteration to percussion or auscultation. The heart was not enlarged, and no thrill or murmur was present. Examination of the extremities revealed no muscular weakness. The tendon reflexes were physiologic.

Examination of the urine showed a 1 plus reaction for albumin. The blood contained 4,640,000 red blood cells and 5,500 white blood cells per cubic millimeter, and 54 per cent hemoglobin. The Wassermann and Kahn reactions were negative. The nonprotein nitrogen content was 12 and the blood sugar 76 mg. per hundred cubic centimeters. Examination of the spinal fluid disclosed 5 white blood cells per cubic millimeter. The total protein content was 4.1 mg. per hundred cubic centimeters; the Wassermann reaction was negative, and the colloidal gold curve showed one point elevation in the fourth tube.

On October 21 the patient was seen by the neurologist, who observed that he had weakness of the upper thoracic muscles, more marked on the right side than on the left. The palate was flaccid and the gag reflex absent, and there was bilateral ptosis. It was the neurologist's impression that the condition was a definite bulbar palsy. Despite the absence of fever and leukocytosis, the cause was thought to be poliomyelitis. Later in the day the respiratory difficulty increased and oxygen was administered nasally. Additional fluids were given parenterally. On October 22 complete respiratory paralysis developed and the patient died. At autopsy there was no histologic evidence of poliomyelitis and no explanation of the cause of the paralysis.

The diagnosis was bulbar paralysis of unknown causation.

CASE 8. — M. M. S., a girl aged 5, was admitted August 25 and dismissed August 27. The morning of admission she awoke with fever, headache and vomiting. She also complained of aching in her neck and stiffness of her back. She was disinclined to walk. Her temperature rose to 104 F. Somewhat later in the day she had several episodes of diarrhea, and she began to complain of sore throat.

On physical examination her temperature was 102 F. Her eyes, ears, nose and throat appeared to be normal except for a slight pharyngitis and some cervical adenopathy. Examination of the chest, heart and abdomen revealed no abnormalities. The neurologic examination gave essentially normal results.

No examination of the urine or of the spinal fluid was made. The blood contained 78 per cent hemoglobin and 6,800 white blood cells per cubic millimeter.

On admission she was placed on a soft diet and was given sulfadiazine and acetylsalicylic acid compound for fever. The day following admission her temperature fell to normal. She was thought to have an infection of the upper respiratory tract and was discharged to remain at bed rest for one week at home.

The diagnosis was common cold (infection of the upper respiratory tract).

CASE 9. — V. M. M., a girl aged 6, was admitted October 5 and discharged October 7, 1943. On the day prior to admission she had become irritable and tired. On the morning of admission she had vomited ten to eleven times and suffered from anorexia. She was reported to have been delirious. On admission she was trembling but complained only of headache and cough.

On physical examination the child was found to be well developed, well nourished, mentally clear and cooperative. Her throat was hyperemic and there was palpable lymph nodes in her neck. The lungs were clear and no abnormalities of the heart were found. The liver descended one finger breadth below the costal margin, and the spleen was barely palpable. Generalized abdominal tenderness was present. No abnormalities of the extremities were apparent. The tendon reflexes were normal. There was no muscular weakness, but some pain on flexion of the neck.

Examination of the urine showed 20 to 30 pus cells and 1 to 4 red blood cells per high power field. There were occasional pus clumps. The first examination of the blood on October 6 showed 78 per cent hemoglobin and 17,050 white cells per cubic millimeter. The second examination revealed 7,150 white cells. The third examination revealed 78 per cent hemoglobin, 8,750 white cells and 4,100,000 red cells per cubic millimeter. Examination of the spinal fluid disclosed 1 white blood cell per cubic millimeter and no red blood cells. The colloidal gold curve showed no elevation in the ten tubes. The Wassermann reaction was negative. In a culture of material from the throat a mildly hemolytic streptococcus predominated.

The patient received no therapy. However, her temperature fell to normal the day after admission. She was discharged on the second day of hospitalization.

The diagnosis was acute pharyngitis (hemolytic streptococcus) and pyelonephritis.

CASE 10. — J. C., a girl aged 11, was admitted August 25 and was dismissed August 28, 1943. The day prior to admission she had suffered from fever, vomiting and headache, and on the day of admission she had chills and frequent bowel movements.

On physical examination her temperature was 103.8 F., and she appeared to be acutely ill. On auscultation of the chest a few rales in the left axillary line were heard. The abdomen was normal to palpation. The neuromuscular examination revealed no abnormalities.

Examination of the urine showed 8 to 10 pus cells per high power field. On admission the blood contained 72 per cent hemoglobin and 20,900 white cells per cubic millimeter; the second day, 74 per cent hemoglobin and 10,400 white cells, and the third day, 72 per cent hemoglobin and 7,100 white cells. A vaginal smear contained many epithelial cells and many mixed organisms. Examination of the spinal fluid disclosed no cells, and the colloidal gold curve showed one point elevation in the first five tubes. The sugar content was 85, the sodium chloride content 650 and the total protein content 16.1 mg. per hundred cubic centimeters.

The patient was given 30 grains of sulfathiazole on admission with 15 grains every six hours thereafter. Her temperature fell to normal in the first twelve hours after admission, and she remained afebrile throughout the rest of her hospital stay. She was discharged improved.

The diagnosis was gastroenteritis of unknown cause.

CASE 11. — B. B., a boy aged 8, was admitted on November 6 and dismissed on November 12, 1943. He had awakened with a headache three days prior to admission. The following day he began to complain of pain in his neck and of weakness. At this time he was seen by a physician, who noted that his neck was rigid. The nurse had observed in the past few days that his arms had been spastic, and he had not taken food. The morning prior to admission the nurse awoke him to give him fluids, and at this time she noticed that the liquid would come back through his nose. On the morning of admission he swallowed a little water with difficulty.

Physical examination revealed that the child was well nourished and well developed and not acutely ill. He apparently had some difficulty in swallowing. Examination of his eyes, ears, nose and mouth disclosed no abnormalities. A slight cervical adenopathy was present. His chest was normal to percussion and auscultation. On palpation of the abdomen, several firm discrete nodules were noted in the left lower quadrant. Examination of the extremities and reflexes revealed no abnormalities.

Examination of the urine showed a faint trace of albumin and occasional pus cells. The blood contained 94 per cent hemoglobin and 7,200 white blood cells per cubic millimeter. The heterophile antibody reaction proved positive in dilution of 1 to 64. Examination of the spinal fluid disclosed 6 white blood cells per cubic millimeter, no red blood cells and a negative Pandy reaction. The colloidal gold curve showed one point elevation in the first five tubes. The total protein content was 24.5 mg., the sugar content 46.6 mg. and the sodium chloride content 675 mg. per hundred cubic centimeters. A complete study of the blood disclosed it to be normocytic, hypochromic and microcytic. Eosinophilia was present. A definite blood dyscrasia could not be diagnosed. A culture of the spinal fluid showed no growth. The sedimentation rate was 10 mm. in the first hour. Test of the blood for typhus and paratyphus agglutination proved negative in all dilutions.

The patient was afebrile during his hospital stay. The several large palpable masses in the left lower part of the abdomen were not relieved by an enema but later disappeared. It was concluded that the patient had a fecal impaction. Nonparalytic poliomyelitis was considered as a possible diagnosis. The patient was discharged to continue at bed rest.

The diagnosis was impacted feces and a questionable poliomyelitis.

CASE 12. — T. F., a boy aged 13, was admitted January 29 and dismissed February 16, 1944. One week prior to admission there had developed a cold and sore throat, from which he apparently recovered, and he had returned to school. He soon noticed that his legs were weak, and on two occasions he fell. His instability became progressive and weakness of both legs developed. Hospitalization was recommended by a local physician.

Physical examination revealed that the boy was well developed and well nourished and did not appear to be acutely ill. His temperature was 99.6 F. and his pulse rate 80. Examination of the nose and throat showed slight hyperemia. The tonsils were covered by a white exudate. There was no glandular enlargements. The chest showed no abnormalities on percussion and auscultation; the heart was not enlarged and there was no thrill or murmur. Palpation of his abdomen revealed no tenderness, masses or palpable viscera. The feet and legs were found to be cold and mottled, and there was bilateral foot drop. The patient was unable to dorsiflex his feet or wiggle his toes, and

all the muscles of the lower extremities were weak. He had weakness in both hands and was unable to grip with force. There was a nasal twang to his speech, and his palate elevated weakly. His eyes reacted to light and in accommodation, and the fundi were normal. His tongue protruded in the midline. He had no facial weakness or nuchal rigidity. The tendon reflexes of the upper right extremity were normal, but those of the left were weak. Both patellar reflexes and the left achilles reflex were absent, and the right achilles reflex was weak. The Babinski sign was absent. The abdominal reflexes were present and equal. Sensory examination showed hyperesthesia to pin prick and brush below the middle of both hands and below both knees. The vibratory sense was diminished at the ankles and the wrists. The gait was of the steppage type.

Examination of the urine showed no abnormal findings. The blood contained 94 per cent hemoglobin and 12,500 white cells per cubic millimeter. The sugar content was 15 mg. and the sodium chloride content 700 mg. per hundred cubic centimeters. The first examination of the spinal fluid disclosed 9 white blood cells and 5 red blood cells per cubic millimeter. The total protein content was 62 mg. per hundred cubic centimeters. The Wassermann reaction was negative, and the colloidal gold curve showed one point elevation in the first four tubes. On the second examination of the spinal fluid, two weeks later, there were 6 white blood cells per cubic millimeter and no red blood cells. The total protein content was 93 mg., the Wassermann reaction was negative and the colloidal gold curve showed one point elevation in the first five tubes. On the first culture of material from the throat the diphtheria culture proved unsatisfactory and a few colonies of pneumococci were isolated. On the second culture of material from the throat *Streptococcus viridans* was the predominating organism.

The patient was given poliomyelitis routine care. After examination by the neurologist, this was discontinued and he received thiamine hydrochloride, 100 mg. intravenously, daily, and a light cradle to his legs. On February 13 the neuromuscular examination was repeated, and at this time the deep reflexes of the upper extremities were found to be normal, the abdominal reflexes present and the patellar reflexes normal. The achilles reflexes were sluggish, especially on the left side. The patient was able to elevate his legs against gravity, and the peroneal muscles, although weak, were strong enough to dorsiflex the feet. He was able to move his toes. Sensory examination showed reduced response to pin pricks and brush stimulation distal to the middle of the hands and the ankles. Vibratory sensation was reduced in the lower extremities, the reduction being greater on the right. The patient continued to improve, and on February 15 he was permitted to sit up in bed. He was discharged the following day to continue to take thiamine hydrochloride, 10 mg. twice daily. His recovery was uneventful.

The diagnosis was infective neuronitis.

CASE 13. — M. S., a young woman aged 23, was admitted September 21, suspected of having poliomyelitis, and dismissed September 22, 1943. The day prior to admission there developed vomiting and diarrhea, which persisted, and at that time she complained of weakness and paralysis of the upper extremities. On the day of admission the paralysis had extended to the trunk and lower extremities. She stated that the day prior to the onset of her illness she had eaten a hamburger, which might account for her gastric symptoms. Five weeks prior to admission she had been delivered of an infant and since that time had not been strong.

On physical examination it was observed that she was unable to flex her head to her chest because of weakness. There were no limitations due to pain. Her eyes, ears, nose and throat were normal. Her chest was normal to percussion and auscultation, and there was no respiratory effort or dyspnea. Her heart was not enlarged, and no thrill was present. A systolic murmur could be heard in the pulmonic area. Examination of the abdomen revealed no abnormalities. The extremities on examination were found to be weak and apparently paralyzed. The patient, when placed in a sitting position, was unable to support herself and fell. The tendon reflexes were all physiologic, but the abdominal reflexes were absent.

Examination of the urine showed no abnormalities. The blood contained 90 per cent hemoglobin and 6,050 white blood cells per cubic millimeter. The Wassermann and Kahn reactions were negative. The nonprotein nitrogen content was 26 mg. and the sugar content 80 mg. per hundred cubic centimeters. The spinal fluid was under an initial pressure of 50 mm. of spinal fluid. It contained 8 white blood cells per cubic millimeter and a total protein content of 30 mg. per hundred cubic centimeters. The Wassermann reaction was negative, and the colloidal gold curve showed one point elevation in the first four tubes.

The patient, because she was suspected of poliomyelitis, was given hot packs, with remarkable therapeutic effect. She recovered immediately from her weakness and was discharged from the hospital the following day with no residual paralysis.

The diagnosis was conversion hysteria.



### Summary

The diagnostic difficulties encountered in an epidemic of poliomyelitis in Kansas during the summer and fall of 1943 are considered.

Of 121 patients admitted to the hospital, 90 were found to have acute anterior poliomyelitis or polioencephalitis. The diagnostic criteria of poliomyelitis are presented.

The 31 cases differentiated from poliomyelitis include cases in which there were various diagnoses. The importance of spinal fluid changes, nuchal rigidity, muscle pain or spasm and motor symptoms in the differential diagnosis are considered.

**Discussion of Papers of A. Theodore Steegmann, and Kathryn L. Stephenson;  
J. Wayne McFarland,\* Lieut. Comdr. Harvey E. Billig, Jr.,  
G. Mosser Taylor and Clarence W. Dail; Ernst Fischer\*  
and Virginia W. Ramsey.**

**Dr. K. G. Hansson (New York, N. Y.):** The first paper by Dr. Steegmann on the diagnosis of poliomyelitis is appropriate at the present time because most papers on poliomyelitis in the last few years have been concerned with treatment. I think we have neglected other parts of poliomyelitis. It is therefore interesting to listen to Dr. Steegmann's very carefully prepared paper on the epidemic.

Poliomyelitis is a virus disease and many of the symptoms that occur should be expected in other virus diseases. He brought out the main points in diagnosis which, are the history, the rigidity of posterior neck muscles, back and hamstrings, muscle weakness and the spinal fluid. I think we should be careful before we report any formal treatment in poliomyelitis, to be sure that we are treating poliomyelitis and not any other disease.

From personal experience I might say last summer I received a young boy from a camp with a diagnosis of poliomyelitis. The camp director had made a diagnosis of poliomyelitis, had had the camp closed and had had the children sent home. The child arrived that evening in the ambulance and when I examined him, since it was during the time when we see poliomyelitis, I thought it was poliomyelitis. By eleven o'clock the boy had mumps which could easily be diagnosed. Therefore, in the confusion of the last few years and our preoccupation with treatment, I am sure that many cases have been dealt with that were not poliomyelitis.

I am also pleased to see that he did not include the non-paralytic type of cases in his discussion.

Dr. McFarland's paper on the Kenny treatment in connection with neurotripsey at first gave the impression that the Kenny treatment has been accepted without

any controversy. I must remind you about the investigation of the American Medical Association not long ago that brought out the answer which was in short words that what is new in the Kenny treatment is no good and what is good is not new. Be that as it may, I believe Dr. McFarland's discussion on neurotripsey is most interesting.

It is discouraging when you have treated a patient for one, two, or three years and all you can give him is a pair of braces, a pair of crutches, or a wheel chair. The slightest hope for such a patient in the form of neurotripsey should be carefully studied and I am sure that we all are looking forward to further reports from Dr. McFarland and his associates.

I was pleased to see that he had retained the muscle testing by which you can really follow any improvement.

I should like to ask Dr. McFarland if he has done any animal experimentation for the histologic changes that might be expected as a result of the neurotripsey.

The last paper, Dr. Fischer's on muscle protein, is one of those that we will look to from now on, thanks to the stimulation from the Baruch Committee on Physical Medicine. We have had so many contradictory reports on nerve regeneration and muscle restoration, it is difficult to know what to believe. The work of the authors on myosin is a scientific approach which should surely clarify our confusion.

The result of Dr. Fischer's work seemed to indicate that massage and electric stimulations are helpful in the prevention or restoration of muscle atrophy. This is, of course, of great interest to those of us in physical medicine. We need proof for what we have been doing in the past.

I should like to ask Dr. Fischer a few

\* Paper by J. Wayne McFarland *et al.*, appeared in the Nov., 1944 issue of the ARCHIVES; paper by Ernst Fischer, and Virginia W. Ramsey appeared in the Dec., 1944 issue of the ARCHIVES.

details about his work. For instance, in applying electric stimulation and massage, did he use electric stimulation as much in time as he applied massage; and, second, did he use any combination of heat, electric stimulation, massage and exercise, which is so often done in the treatment of atrophied muscles? Also, is it rational to accept everything that is seen in animal experimentation as of the same value as on the human body?

I hope he is right and I hope that in the near future we will hear more reports on this subject from the University of Virginia Medical College.

**Dr. Jessie Wright (Pittsburgh):** I have been meeting some of the problems mentioned by Dr. Steegman when I have been called to make the diagnostic study on 185 patients suspected of having poliomyelitis in the recent seasonal outbreak in Pittsburgh. To September 8, 1944 the following types have been encountered: 44 bulbar and bulbo-spinal; 2 bulbo-encephalitis, 6 poliomyeloencephalitis; 2 facial nucleus palsies with spinal poliomyelitis; 85 poliomyelitis or spinal type; 7 abortive or non-paralytic with suggestive spinal fluid findings, and 2 lymphocytic meningitis followed in a few days by lower cell counts and typical clinical asymmetric muscle weakness of poliomyelitis. This makes a total of 148 with infantile paralysis.

Thirty-seven others suspected of having infantile paralysis proved on examination to have other affections. Of these 7 had illnesses resembling poliomyelitis in some respects but lacked the characteristic individual muscle impairment of irregular distribution. They proved to have meningitis or meningeal irritation associated with acute infectious diseases. Of the rest, 3 had acute monarticular arthritis; 1 had acute myositis of the back following chilling; 1 nurse had derangement of the lower back with pain and muscle spasm; 1 patient with osteitis fibrosa cystica of the upper end of the left femur had developed a sudden limp and pain on movement; 2 patients had injury to the cervical spine with paralysis, paresthesia, and blood in the spinal fluid; 1 young married woman had hemiplegia following vascular insult, and 1 child of eight had fracture of the upper end of the right humerus.

The rest of the 37 had typical tonsillitis, rheumatic fever, undulant fever or gastrointestinal illness.

Three of the 85 spinal cases of poliomyelitis had tetanic appearance at onset but soon showed typical asymmetric lower motor neuron cell involvement and improved under treatment.

Each year we have one or more patients sent in as poliomyelitis in whom we find evidence of polyneuritis as described by Dr. Steegman.

The paper by Drs. Steegman and Katharine Stephenson makes clear the necessity for accurate diagnosis if statistical reports of recovery by various methods are to be of value.

The paper by Drs. McFarland, Billig, Taylor and Dail should be of interest to any of us dealing with large numbers of patients with poliomyelitis and the procedure merits further trial.

Sections taken from poliomyelitic muscle by Hipps on old cases and by me on recent cases suggest an alternation of bundles of fibers not affected with groups of fibers which have undergone metamorphosis to fibrous tissue resulting in loss of muscle fiber function and substance. If neurotomy or fibromyotomy could be done at an optimum time before affected neuromuscular units change to scar tissue, we might hope to stimulate branching and growth of unaffected axons and also to disrupt early networks of limiting fibrous strands. The authors have made progress in this direction. I wonder if part of the improvement in pliability, warmth, and function may be due to disruption of scar tissue and to better circulation resulting from therapeutic trauma following manipulation by a blunt instrument.

Dr. Fischer and his associates are doing some much needed investigation to establish the scientific basis for certain measures used in physical medicine. Such study will make more accurate prescription possible.

**Dr. Miland E. Knapp (Minneapolis, Minn.):** I should like to take this occasion to discuss one or two of the papers presented. The statement was made that patients showing no paralysis require no treatment. I do not agree with this statement because we have all seen patients in the past with no demonstrable paralysis which end in scoliosis after a period of six months to a year.

Regarding the paper by Dr. McFarland and his group, it seems to me that it is not unlikely that at least some of the improvement that has been recorded in those patients is due to the release of the fibrosis in the muscle, that is, the release of shortening rather than any increase in innervation. I have watched that work done; in fact, I helped Dr. Billig do a case in California last summer. After seeing the procedure, I have carried it out; only I have worked it on the opposite theory. I do the operation on the muscle that is short instead of the muscle that is weak, and I have had nice results, so that I would like to suggest the release of shortening as a possible explanation for at least some of the good results.

**Dr. Madge C. L. McGuinness (New York, N. Y.):** Neurotomy is of particular interest to me because it offers possibilities in heretofore hopeless cases. The first patient treated by Dr. Billig was that of the son of a medical friend. This boy had been left with the usual results of a severe case of poliomyelitis contracted six years previously.

With others of his class, after Pearl Harbor, he wished to join the Navy but, of course, his physical disability and the wearing of a brace precluded such a possibility. It was, therefore, of much interest to those

of us who followed the case to note the satisfactory results of neurotripsy. The young man passed his Navy examination and, according to his medical mother, is 100 per cent. The reports of other cases done since are equally encouraging and, with these as a standard, hopes can be held out of ameliorating some conditions formerly considered untouchable.

**Dr. Clarence W. Dail** (Loma Linda, Calif.): From clinical observations the results in the treatment of muscles of the forearm, hand, lower leg, and the foot appeared as good as those obtained in the treatment of the larger muscles. The small muscles were not included, however, in the figures reported, since grading is not as accurate as with the large muscles, which can be tested more definitely against gravity. Since the muscles of the back were evaluated on a different basis, they were also excluded from the report. Definite improvement in the ability of the patient to arch the back from a prone position was observed in most patients whose back muscles were treated.

The same methods of evaluation and of treatment are employed during the first five months' period following neurotripsy as are employed later. Evidence of the value of the procedure appears definite since improvement is practically confined to this early period.

Although the objective signs of improvement of muscle strength after neurotripsy are apparently slight, they are sufficiently constant to make the procedure worthy of trial in any case showing muscle weakness sufficient to impair useful function. Muscles which are to be thus treated should have reached a stage during which there is no more improvement of strength.

From our findings it appears that the muscles with a zero grade show much less chance of improvement from this procedure than the partially involved ones. With absolutely no nerve supply to the muscle one cannot expect any improvement. With a zero grade, however, there may still be a slight but undetectable nerve supply which can be stimulated by neurotripsy.

**Dr. A. Theodore Steegmann** (closing): I should like to thank Doctor Hansson and Doctor Wright for their discussion. Of course, this paper was written primarily for general practitioners and other physicians who may run into these problems during an epidemic. We soon found out that almost anything may come in as a suspected poliomyelitis. I was glad Doctor Wright mentioned other types of cases that might be confused with poliomyelitis.

**Dr. J. Wayne McFarland** (closing): I wish to thank Dr. Hansson and Dr. Wright for their discussion. There will be quite a list of references with the published paper, but if you want something on histology that has been done, I can refer you to Billig and Van Harvell, U. S. Nav. M. Bull., March, 1943; and on nerve regeneration, Langley and Anderson, J. Physiol., 1902, and Watrous, Proc. Soc. Exper. Biol. & Med., 44, June, 1940.

I have not performed any studies on histology. There is quite a bit of extensive literature on that, however, in *Nerve Injuries*, by Pollock and Davis.

I should like to say that we do feel pretty strongly, that the Kenny method is doing well in poliomyelitis out our way, in the acute stages, where we place the emphasis. We hope that we have given with neurotripsy or nerve crushing, a new addition to be carried out along with other treatment.

**Dr. Ernst Fischer** (closing): I wish to thank the discussers for their kind remarks. In answer to the question of Dr. Hansson, concerning differences in atrophy in various species: There exists only a difference in the time factor of atrophy. In some species atrophy occurs quickly; in others much more slowly. If one attempts to compare the state of atrophy in men and in animals, one might say that such a comparison is possible if the loss of weight is taken as index of comparison. If a human muscle has lost 50 per cent weight it corresponds to denervation atrophy in a rat of twenty-four days duration.

The periods of electrical stimulation were short, twice daily for a few minutes. Periods of strong stimulation five in number of twenty seconds' duration, were applied, with periods of rest of about thirty seconds between. It is well known now that no long stimulations are necessary. The stimulations were done with various currents, their shape and strength adapted to the excitability of the muscle at that day on which the muscle was stimulated. Only in this way, can one get beneficial effect by electrical stimulation. Over stimulation must be avoided, and currents must be used which represent the minimal electrical energy for producing maximal contraction of the muscle.

The time of massage was twice daily, for a period of five minutes. No combination of electrical treatment, massage, or other treatment has yet been used.



# **FREEZING TREATMENT OF TUMORS \***

**(Preliminary Communication)**

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The method here described has developed from previous observations<sup>1</sup> on the selective destruction of tumors by temporary local asphyxia. Other pertinent experiences are the massive freezing of large neoplasms dating back to Arnott and Velpeau a century ago, the use of carbon dioxide snow by dermatologists for removing small superficial growths of benign or feebly malignant character and the cooling of tumors to milder degrees for longer periods by Fay and Smith.

The differences between our method and previous ones appear to be three. A. The freezing with carbon dioxide ice is continued longer than in other methods as far as we are aware. B. Accordingly, larger or more invasive tumors are treated. C. The concept of the treatment is new, for reliance is placed not merely on a direct killing effect of freezing but on the ensuing inflammatory reaction, which presumably embodies the same principle as the local asphyxia previously mentioned.

Three of the simplest cases of our series will be summarized briefly as illustrations:

**CASE 1.** — W. D., a man aged 57, was admitted to City Hospital Oct. 17, 1944, for bronchitis. This condition cleared up. There was a crusted ulcer on the left side of his lower lip, and a palpable induration under it about 2 cm. in diameter occupied practically the full thickness of the lip, from mucous membrane to skin. Biopsy identified it as a squamous cell carcinoma. A submaxillary lymph gland of hazelnut size on the left side was removed and found noncancerous. A smaller gland over the right sternoclavicular joint later disappeared spontaneously.

November 17, with local procaine anesthesia, rubber ligatures were inserted in series through punctures made in a circle 1 cm. or more from the apparent margin of the tumor, in such manner that when tightened they would shut off all circulation to the tumor area. The area was thus asphyxiated for two hours daily for five days (Nov. 17 to 21 inclusive). The purpose was to cause sufficient inflammation to destroy the tumor. The previous demonstration that tumors can thus be broken down by the reaction following multiple brief ligations is one of the proofs that the destruction is not explainable by any imaginary intolerance of tumor cells for prolonged asphyxia. Instead of the hoped-for sparing effect, however, the plan in this location actually introduced more damage to normal tissues than the usual single long ligation. The rubber bands were left in place throughout the five days, and by being tightened for two hours daily they set up an inflammation which not only was painful but also made the compressed tissues friable. The result was a cutting effect of the ligatures, such as does not occur with a single long ligation. Laterally the lip retained its connections and circulation, but mesially the area was separated so that suturing was necessary to close the gap.

For this reason the ligatures were removed on November 22 and the ligation procedure was abandoned. The desired effect was in progress, because as the inflammation subsided it was evident that the tumor had partially sloughed while the surrounding normal tissues were intact. By the end of December, after the sutured lip had completely healed, the tumor had grown back to its original dimensions.

Jan. 8, 1945, two pieces of carbon dioxide ice the size of the tumor were applied, one on the outer and one on the inner surface of the lip, and the tumor was compressed between them for one minute. January 15, the ice was similarly applied with

\* From the City Hospital, Welfare Island, N. Y.

1. Allen, F. M.: Local Asphyxia and Thermal Modifications in the Treatment of Tumors, Arch. Phys. Ther. 25:391 (July) 1944. Other references are given in this article.

pressure for two minutes. Though considerable breaking down of the tumor ensued, it seemed probable that the duration of application was not long enough for adequate effect on the center of the tumor. Therefore, on January 22 the ice was applied for six minutes.

The result was a severe inflammation, but without such pain as resulted from the ligation. The tumor softened and there was a discharge from the original ulcerated surface, but both the skin and the mucous membrane where the ice was applied remained unbroken. Complete healing followed, without any visible scar except that resulting from the ligation. The cure remains complete up to the present.

We are not aware that carbon dioxide freezing has ever been used heretofore to treat tumors for such a length of time or to such a depth of infiltration. The squamous cell carcinoma being classed as radioresistant, it is improbable that radiation therapy could have destroyed this tumor without atrophy or sclerosis of the neighboring tissues. Surgical excision would have left a large deficit, necessitating plastic repair. Except for the mistaken plan of ligation, the practical result was an easy cure without pain or scar.

CASE 2. — F. D., a white man aged 78, weak and emaciated, had numerous warts on both hands. He came for an office examination because of an ulcer the size of a silver dollar on the dorsum of the left hand, which evidently resulted from the breaking down of a large wart and which had been treated with various applications for many months but continued to grow larger. Biopsy showed it to be a squamous cell carcinoma. The patient was not hospitalized.

In the office on Aug. 8, 1944, a piece of dry ice slightly larger than the tumor area was applied with moderate pressure for ten minutes. The region was dressed with a bland ointment and a loose bandage. The same treatment was repeated one week later, and again ten days after that. Each treatment resulted in a large swelling of the back of the hand, which was tender but not painful and mostly subsided in three or four days. The final healing progressed rapidly. The finished result was seen on October 8, when the back of the hand showed a soft, pliable, superficial scar scarcely larger than a dime, having only a slight extra pinkness compared with the surrounding brownish senile skin.

Drastic treatment was here used for the sake of assurance, because the depth of infiltration of the tumor was uncertain. As the original ulcer would necessarily have left a scar, it is undecided whether any scarring resulted from the freezing. Negative evidence is the fact that the final scar was so much smaller than the ulcer and there was never any appearance of necrosis of the surrounding normal tissues. This is our most radical use of freezing thus far, and our impression is that the case is unprecedented in respect to the time and intensity of cold and the selective destruction of tumor as compared with normal tissue. Others<sup>2,3</sup> have used freezing up to ten minutes, but not for tumors, and Weitzner classes malignancy as a contraindication. Theoretically, we believe such a contraindication in the uterine cervix to be an error. But our more complete observations show differences in resistance between different normal regions of the body and also between different tumors; therefore the methods are still tentative and positive conclusions are reserved.

CASE 3. — V. H., a white man aged 51, a business man, was seen in the office Oct. 6, 1944. During the previous May he had noticed a supposed pimple in the center of his right cheek. He attempted to squeeze pus out of it and it grew larger. He had no complaint except the slow continuous growth of the nodule and an occasional slight "drawing" sensation in it. Three weeks before this consultation, a biopsy in a cancer hospital had furnished a diagnosis of "anaplastic endothelioma."

On examination, a firm elevated nonulcerated mass was observed in the middle of the right cheek, palpable to the extent of a diameter of 2 cm. and a depth of about 1 cm. It was slightly pinker than the surrounding skin but not inflamed or tender. The only noteworthy fact in the patient's prior history was that he had suffered a severe roentgen ray burn in the treatment of tuberculous neck glands twenty-seven years previously and therefore was strongly averse to the radiation treatment which had been advised for the tumor.

2. Weitzner, G.: The Treatment of Endocervitis with Carbon Dioxide Snow (Dry Ice), *Am. J. Surg.* 48:620 (June) 1940.

3. Hall, F. E.: The Use of Quick Freezing Methods in Gynecologic Practice, *Am. J. Obst. & Gynec.* 43:105 (Jan.) 1942.

A piece of carbon dioxide ice large enough to cover the tumor and about 0.5 cm. additional around its circumference was applied for five minutes with firm pressure. There was the usual immediate effect of a white, solidly frozen, depressed area. After six to eight minutes this area had become moderately swollen and red. Within ten minutes a bluish color of the tumor demarcated it from the surrounding skin, and this color became darker, just as after a ligation treatment. Two hours later hyperemia and swelling were predominant and small blebs had formed under the epidermis.

After twenty-four hours (October 7) the frozen area was found to be covered with a large superficial blister and the entire side of the face was greatly swollen, but painless. The visible part of the tumor was dark blue, and the surrounding normal skin was a bright inflammatory red.

During the following days the black necrotic tumor gradually softened and discharged, while the normal tissues remained red and free from any visible necrosis. The blisters were replaced by a dry crust. Within a month healing appeared complete. A tiny scar at the site of the tumor was scarcely perceptible. The frozen area retained the texture of normal skin and was distinguished only by a faint pallor. A casual observer would not notice anything abnormal in that side of the face, then or up to the present time.

#### Comment

A salient feature of this treatment is the freezing with carbon dioxide ice for longer periods than have heretofore been employed. Our maximum thus far has been a ten minute application with pressure, repeated three times, but the actual tolerance limit is not yet established. The longer periods provide deeper penetration of the cold and increase the degree and extent of the ensuing inflammation. Too long an application must cause an indiscriminate necrosis of tumor and normal tissue, like the massive freezing methods of the previous century. The item of essential interest is the seemingly selective necrosis of the neoplasm, so that apparently every tumor cell dies and every normal cell survives. The high resistance of cancer cells to cold, which is familiar in the literature, furnishes one argument for the still tentative hypothesis that the destruction is somehow connected with the ensuing inflammation and thus may be identical with the results of temporary local asphyxia.

On this assumption, the effects of freezing are radically different from those of cautery, of either the thermal or the electric kind. In addition, the practical painlessness of the freezing treatment eliminates the need for anesthesia, and even if the duration is extended to the point of killing some normal tissue, the peculiarity of the healing process is such that, within certain limits, a disfiguring or deforming scar need not be anticipated. The ideal, however, is to obtain selective necrosis of the tumor with no lasting damage to the normal tissues. The limits of success in this endeavor are yet to be ascertained. We shall publish attempts which have already been made with neoplasms of greater size, depth or malignancy, either with failure or with benefit in the form of cure or palliation. To enlarge this experience, we shall welcome cooperation from physicians who have cases of accessible tumors which are promising for this treatment or hopeless under other treatments. Notwithstanding the obvious limitation of the method to tumors which are localized and accessible, we hope to demonstrate some practical advantages under certain conditions or in certain locations.

#### Summary

Three cases are reported, illustrating the cure of small skin tumors by freezing with carbon dioxide ice. The new features are the longer duration of freezing, the corresponding ability to treat larger or deeper growths and the theory of an inflammatory rather than a direct destructive mechanism. This is in agreement with the fact, mentioned in previous papers, that while some types of inflammation stimulate tumors the type following temporary local asphyxia tends to destroy them. In selected cases the method may prove preferable to use of the knife, cautery or radiation.



## ANALYSIS OF THE WAC EMERGENCY PHYSICAL THERAPY TRAINING PROGRAM \*

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During the 1943-44 school year three civilian installations were called on to accept enlisted members of the Women's Army Corps for emergency training in physical therapy. This was necessary because the need for technical specialists in this field exceeded the combined civilian supply and the student capacity of Army Hospital training schools, which were then undergoing rapid expansion. The University of Wisconsin was one of the civilian institutions selected for this work. For many years it had maintained a typical twelve month hospital training school of the apprentice type, open to registered nurses and graduates in physical education. In this course little attention was given to either the basic or the medical sciences. Full reliance was placed on the adequacy of prerequisite training in the former except where deficiencies were gross. These were made up by the assimilation of physical therapy students in general elementary college courses. The requirement in pathology had long been met by the expedient of allowing trainees in physical therapy to attend the lectures given to second year medical students. No formal instruction was given in any of the branches of medicine and surgery related to the practice of physical therapy. For approximately two years prior to the initiation of the WAC training program, full responsibility for the teaching of the principles and practices of all technical subjects had rested on a technical staff composed, with one exception, of hospital employees working a forty-two hour week in the physical therapy clinic.

The details of the contract which covered the WAC physical therapy program entailed such a radical and precipitous revision in the approach to technician training at the University of Wisconsin that the experience of organizing and administering it became an involuntary experiment in pedagogy born of the urgent need for a streamlined training of reasonably skilled personnel in relatively large numbers. By the time the second detachment of WACS assigned to the University of Wisconsin was ready for graduation, the first had served its apprenticeship in competition with students trained elsewhere, had been evaluated in the field, had been commissioned and had been assigned to Army hospitals for duty. The data thus accumulated yielded interesting information on the merits and weaknesses of the accelerated program and the expectancy with which students exposed to it might face their professional future. This evidence was originally gathered together informally, in a manner which would permit the second WAC detachment to evaluate its experience and achievements in comparison with the academic and service record of the companion unit already in the field. At the suggestion of Dr. John S. Coulter, the analysis was summarized for publication, problems of purely local interest being omitted.

### Subjects of Investigation

The two groups observed during successive six month periods were composed of thirty-two enlisted members of the Women's Army Corps and eight civilians. The academic prerequisites for specialist training in physical ther-

\* From the Section of Physical Medicine, Department of Medicine, University of Wisconsin, and the Baruch Center of Physical Medicine, Medical College of Virginia.

apy were identical with those established for the duration of the emergency by the Council on Medical Education and Hospitals of the American Medical Association.<sup>1</sup> WACS assigned to these training units were selected by the Surgeon General from volunteers applying for admission. Since they were volunteers, the candidates may be considered to have possessed desirable traits of initiative, ambition and interest. Few were motivated primarily by the chance thus offered of attaining commissioned officer status. The majority were well informed on the postwar professional future of such specialization and were prepared to take full advantage of their opportunities.

The two groups to be trained showed a wide variation in backgrounds. Previous education ranged from two years of college work to candidacy for the doctorate degree in medical sciences with specialization in exercise physiology. Five candidates had had only two years of college work, seven had had three, nineteen had had four, and nine had pursued varying amounts of graduate study. Approximately 50 per cent came from the field of general education or physical education. The remaining had specialized in the following diverse subjects: home economics, biology, bacteriology, pre-nursing, physiology, premedical and other studies. An approximate estimate of the caliber of previous college work indicated that both groups were composed very largely of average students rating a little above C in the level of academic attainment. Only one had graduated magna cum laude. A number had attended several different institutions. Those who had completed their college work in one school were in the minority. Some had been enrolled in as many as four different colleges. It is a curious fact that this small group of students had studied in fifty different American institutions of higher learning, the majority having been enrolled in small colleges or teacher training institutions of circumscribed influence and reputation. One had studied abroad.

The schools attended for undergraduate studies were the following: Alabama College, Montevallo, Ala.; Belhaven College, Jackson, Miss.; Boston University, Sargent School of Physical Education; Central State College of Education, Greeley, Colo.; Dana College, Blair, Neb.; Georgian Court College, Lakewood, N. J.; Heidelberg College, Tiffin, Ohio; Iowa State Teachers College; Lindenwood College, St. Charles, Mo.; Louisiana State University; Los Angeles Junior College; Miami University, Oxford, Ohio; Milwaukee State Teachers College; New Mexico State Teachers College; Ohio State University; Oklahoma College for Women; Oregon State College; Pennsylvania State College; Rollins College, Winter Park, Fla.; St. Helen's Hall Junior College, Portland, Ore.; San Jose State College; San Luis Obispo Junior College; Santa Monica Junior College; Slippery Rock State Teachers College; Southwest Missouri State Teachers College; Southwestern Louisiana Institute, Lafayette, La.; State College of Washington; State Teachers College, Flagstaff, Ariz.; State Teachers College, Livingston, Ala.; State Teachers College, Lock Haven, Pa.; State Teachers College, West Chester, Pa.; University of California; University of Colorado; University of Kansas; University of Minnesota; University of Nebraska; University of Oregon; University of Washington; University of Wisconsin; West Virginia University; Western College, Oxford, Ohio; Western Kentucky State Teachers College; Whitman College, Walla Walla, Wash.; Wittenberg College, Springfield, Ohio; Womans College of the University of North Carolina.

Those attended for graduate study were the following: Oklahoma A. & M.; Pennsylvania State College; University of Colorado; University of

1. "Essentials of an Acceptable School for Physical Therapy Technicians," Council on Medical Education and Hospitals of the American Medical Association, revised June, 1943.

Minnesota; University of Pennsylvania; University of Pittsburgh; University of Wisconsin.

An examination of the Army General Classification Test (AGCT) scores of the WAC trainees assigned to Wisconsin indicates they were highly selected from the viewpoint of military organization. The General Classification Test purports to estimate the "ability to learn, to comprehend and follow instructions, to think quickly and accurately, to analyze a situation, and to keep . . . mentally alert."<sup>2</sup> It had been set up in 1940 by a Committee on Classification of Military Personnel advisory to the Adjutant General's Office, and supplanted the old Army Alpha and Beta general intelligence tests previously given to applicants for enlistment.<sup>3</sup> The AGCT was scaled and standardized on 5,000 men, and since its initial use at the time the first selectees reached Army reception centers from induction stations it has been taken by approximately 8,000,000 persons in one of several variously improved forms. We accepted it as the most valid and reliable measure available to us of the quality of the students we were expected to guide through a highly intensified and academic training program.

The standard score distribution of the AGCT is divided into five grades indicative of learning capacity. Thus 22.5 per cent of the WACS were classed as very rapid learners, 64.51 per cent as rapid learners and only 12.58 per cent as average learners. In spite of mediocre previous academic records, 87 per cent of the WAC group were superior in their relative ability to learn. As far as could be determined, the AGCT grade limits are identical for enlisted men and women, even though the average educational level of the women is higher than that of the men.<sup>4</sup> In general only enlisted personnel in grades I, II and III are selected for specialist training, and candidates for officer training must have a minimum score on the General Classification Test of 110. Although successful physical therapy trainees qualify for subsequent commissions as second lieutenants, four of the thirty-two WAC's assigned to the University of Wisconsin had lower average AGCT scores. This probably indicates conflict between the quality of the candidates desired by the Office of the Surgeon General and the material available for selection from volunteer applicants in the ranks of the WAC. All four brought compensating characteristics, in the form either of exceptional civilian experience or of special aptness for Army life.

The majority of the WACS assigned to Wisconsin were seasoned trainees well adjusted to the discipline of military life. A manifest devotion to the branch of service represented was one of the most conspicuous attributes of the group. The fact that these trainees were studying as WACS under military discipline for a cause outside of and greater than self made for a homogeneity of purpose and effort rarely met in the teaching of civilian students. A negligible proportion of the resources of the staff had to be expended in morale building or motivation.

#### Physical Plant, Equipment, Personnel and Housing

Tuition, room, board, books and incidental fees for all WAC students were paid for by the Army or the university. The trainees received in addition the regular pay commensurate with their rank, which ranged from private to sergeant. The barracks assigned to the WAC detachment pro-

2. "Enlisted men. Initial Classification," Army Regulations No. 615-25, July 31, 1943.

3. Bingham, W. V. et al.: "Report of the Committee on Classification of Military Personnel Advisory to the Adjutant General's Office," *Science* 93:572 (June 13) 1941; Staff, Personnel Research Section, Classification and Enlisted Replacement Branch, The Adjutant General's Office: "Personnel Research in the Army. I. Background and Organization; II. The Classification System and the Place of Testing; III. Some Factors Affecting Research in the Army; IV. The Army Specialized Training Program," *Psychol. Bull.* 40:129 (Feb.) 1943; 205, March, 1943; 271, April, 1943; 429, June, 1943. Bingham, Walter: "Personnel Classification Testing in the Army," *Science* 100:375 (Sept. 29) 1944.

4. Education of U. S. Armed Forces, A. A. A. S. Bulletin, 3:74 (Oct.) 1944.



vided single or double rooms with individual study tables, desk lamps and book shelves. Each student was issued a copy of a standard textbook of medical anatomy, elementary textbooks of physiology and pathology, one of the best available books on physical medicine and small works on bandaging, first aid, muscle testing and reeducation procedures. Copies of all recently published books dealing with physical therapy and standard works in medicine, neurology, psychology, physics, general surgery, orthopedic surgery and dermatology were available to the group as a whole, as well as monographs dealing with specialized aspects of physical medicine, such as massage and therapeutic exercise. Reprints of current papers in exercise physiology, war medicine and physical therapy were kept at the barracks, along with journals covering the same fields. These materials were made thus accessible in order to protect the limited time available for study.

Although the WAC physical therapy program was not an official part of the university's Army Specialized Training Program, many details of its administration were handled through the ASTP office, and all regulations concerning study hours and holidays were identical with those in force for the men. Thus two and a quarter hours of home study per night six nights a week were compulsory, superimposed on the forty-eight hours per week of formal classroom, laboratory or clinical work prescribed by the Office of the Surgeon General. Meals were served in the State of Wisconsin General Hospital, and, with the exception of anatomy, training was conducted in adjoining buildings so that little time was wasted in getting to and from the clinic or classroom.

The State of Wisconsin General Hospital and its affiliated units, the Wisconsin Children's Orthopedic Hospital, the University Infirmary and the Neuropsychiatric Institute, has a combined bed capacity of approximately 700, divided between the various branches of medicine, surgery and the specialties. During the 1943-44 school year these units were served by two well equipped physical therapy departments staffed by ten technicians and two fever nurses, seven of whom were available for teaching and supervision.

### The Curriculum

A detailed program of instruction was outlined by the medical department of the Army. The didactic course was twenty-six weeks long. The prescribed instruction day was eight hours in duration six days per week, or forty-eight hours a week, for six months without interruption. Taken in toto, the program of instruction for physical therapy aides authorized by the War Department on September 11, 1943 more than met the minimum requirements of the "Essentials of an Acceptable School for Physical Therapy Technicians," published by the Council on Medical Education and Hospitals of the American Medical Association in June, 1943, although deviating from the Council's curriculum in several respects. The medical director of the training program was given authority to modify the prescribed program as necessary to make the best use of existing instructional facilities and expedients. A comparison of the two curriculums is presented in table 1.

To expedite analysis, subjects are grouped into four major categories: basic sciences, medical sciences, technical subjects and clinical practice. No effort is made to designate the distribution of time between so-called theory and practice. Hours utilized in the application of physical methods to special fields of medicine or surgery were added to those already carrying the designation "clinical practice." To reduce "hours" to a more commonly understood pedagogic denominator, credit value was assigned to the subjects of the WAC curriculum. Certain fractional unit courses were grouped to

avoid multiplicity of titles on the university's transcript. It was estimated by Dr. W. J. Meek, acting dean of the medical school, that the work done could be fairly valued at one and two-tenths credits per week, or approximately thirty-two credits in toto. Thus the didactic work done in the intensive emergency course was valued as the equivalent in content to that

TABLE 1. — *Comparison of American Medical Association and War Department Curricula\**

	AMA Hours	WD Hours	Credits
Basic Sciences —			
Anatomy .....	210	200	6
Physiology .....	75	30	2
Pathology .....	30	25	1
Medical Sciences .....			4
General Medicine .....	15	15	....
General Surgery .....	15	15	....
Orthopedic Surgery .....	15	15	....
Neurology (including Psychiatry in WAC course).....	10	22	....
Dermatology .....	0	5	....
Peripheral Vascular Diseases.....	0	5	....
Roentgenology .....	0	10	....
Psychology .....	15	10	....
Technical Subjects —			
Electrotherapy .....	65	75	3
Hydrotherapy .....	20	40	1
Massage .....	55	90	2
Phototherapy .....	10	40	1
Therapeutic Exercise .....	105	100	4
Muscle and Sensory Tests.....	0	25	1
Journal Club .....	0	20	1
Preclinical Studies .....			1
Hospital Ethics and Administration.....	5	5	....
Bandaging .....	0	27	....
Sterile Technic .....	0	3	....
Casts and Splints.....	0	3	....
Dressings .....	0	2	....
Clinical Practice .....	505	362	5
Processing, orientation and conferences.....	0	104	0
Electives .....	50	0	....
Apprenticeship —			
WAC .....		624	0
Civilian entering Army service.....		1,248	0

done in the average two semester or three-quarter college school year. In fact, it exceeded this, as will be pointed out later. The number of hours per diem devoted to classroom work, laboratory exercises, clinical practice and study fell much beyond that expected of the civilian college student. It is important to observe that the WAC program is an intensified study schedule and in no sense a condensed one. It is a matter of documentary evidence that in scope, quality, arrangement and facilities the six month WAC curriculum significantly surpassed anything previously given at the University of Wisconsin in the regular year course, which differed little from the average program of the prewar hospital training school.

\* The symbol AMA refers to the curriculum of the Council on Medical Education and Hospitals of the American Medical Association, revised in June, 1943. The course is thirty-six weeks long. Full certification follows 1,200 hours of didactic training and clinical practice. The symbol WD refers to the program of instruction for physical therapy aides in civilian installations and schools under the direction of the medical department of the Army. The course is twenty-six weeks long. This is followed by a compulsory three month apprenticeship for Army trainees and a six month apprenticeship for civilian students entering Army service. The total duration of training thus ranges from thirty-nine to fifty-two weeks. Full certification is granted after the completion of 1,842 hours of didactic work and clinical practice by members of the WAC and 2,496 hours by civilian students.

Credit values were arrived at by taking into account not only the percentage of the total time devoted to a certain course but also its content and the relative importance of the material presented. For example, lectures in the medical sciences have only a broadening or cultural value to the technician, in contrast with the fundamental nature of the basic sciences and the pivotal importance of the technical subjects. With this introductory information in mind, the two curriculums may be objectively compared.

Much has been said about the "lowering of standards" inherent in the accelerated emergency training program, especially that administered by the Army. Careful study of the scope and content of the WAC course suggests that in reality it surpasses anything previously attempted by the average apprentice type of approved hospital technician training school. With this well balanced didactic program, plus the quantity and variety of clinical material available during the apprenticeship and subsequent period of Army hospital service, the close and excellent supervision of technicians by the director acting for the Surgeon General and the unparalleled opportunities for continuation study in the Medical Corps, trainees enrolled in these courses may be expected to contribute in full measure to the advancement of the field during their postwar professional careers.

#### Pedagogical Policies

Apprenticeship to a master technician is an ideal way of learning craft skills. However, the method fails when there is a premium on time, when experienced teachers are scarce and when students must be taught in large numbers. The modern physical therapist is a highly trained assistant to the physician and must exercise judgment in the application of many technical procedures about which the physician not specializing in physical medicine knows astonishingly little.

The transition from apprentice teaching to formal didactic training was expedited at the University of Wisconsin by exceptional cooperation on the part of the university as a whole, the faculty of the medical school and the staff of the State of Wisconsin General Hospital. All teaching was done without recompense as a contribution of the university to the war effort. The curriculum was built on the block system, attention being concentrated first on the basic and medical sciences, then on the technical subjects and, finally, on supervised clinical practice. Every course in the curriculum was organized to meet the specific needs of technicians preparing for Army service and was presented in the best possible sequence, usually in short time concentrated periods of study, irrespective of vacations and regardless of the burden thus imposed on the extradepartmental teacher. All basic and medical sciences were taught not only by physicians but by specialists in their respective fields, who were likewise university teachers of experience. Several fundamental courses were taught by department heads in the general belief that highly concentrated courses require the perspective of long familiarity with the field being presented. Bacteriology, psychology, and anatomy were conspicuous examples. The chairman of the anatomy department, Dr. Walter E. Sullivan, devoted unlimited time to the development of a new course in "living anatomy" aimed at the specific needs of the physical therapy technician. Great energy and imagination went into the teaching of technical subjects by the laboratory method. Mimeographed materials and other teaching aids designed to accelerate learning were used extensively, and traditional methods of doubtful pedagogical value were stringently curtailed.



### Evaluation of the WAC Training Program

The examination of the American Registry of Physical Therapy Technicians appears to be the most objective test of general knowledge in physical therapy currently available. As far as could be determined, no more valid and reliable measure exists. Scores on the Registry examination were therefore taken as a rough criterion of the adequacy of the various phases of the WAC training program set up at the University of Wisconsin. Vice versa, school estimates of knowledge, theoretical and practical, may be taken as a crude measuring stick of the precision with which the Registry examination differentiates between poor and superior students.

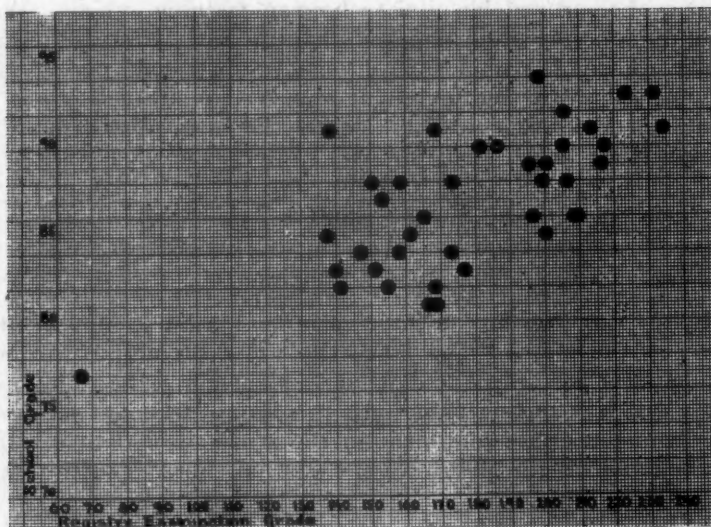


Chart 1. — Relation of the average numerical school grade, weighted by the credit value of individual subjects, to the Registry examination score.

The first spot diagram relates the average numerical school grade, weighted by the credit value of individual subjects, to the Registry score. Though the sample is small, the data suggest a reasonably good relationship between the variables being compared. In general, the student with a high score on school examinations does well on the Registry test and vice versa.

Frequency histograms were drawn up for study of the spread of grades in the various phases of the training program. Those covering both the basic and the medical sciences approximated a normal distribution. This was not true of the scatter of scores received in technical subjects, clinical practice or general efficiency. These frequency histograms were skewed to the high side of the grading scale in theoretical knowledge of technical subjects and to the low side in those intangible qualities which go to make up the art of the practice of physical therapy. One is inclined to challenge the validity of these grades, since the measures used were for the most part constructed and applied by technicians of limited practical experience, the majority of whom had never taught before, and who had never themselves been exposed to formal didactic training in the subjects they were teaching. The necessity of using technicians of circumscribed experience who had been trained by the apprentice method as teachers was one of the most serious hazards jeopardizing the program in its initial stages. These technicians were skeptical of the supposed merits of the new pedagogic approach, since they had learned largely by independent study and the emulation of the

technicians to whom they had been apprenticed. In contrast, the caliber of the teaching in the basic sciences was exceptionally high. That in the medical sciences was also good, and in these areas course grades more nearly fell on a normal distribution curve.

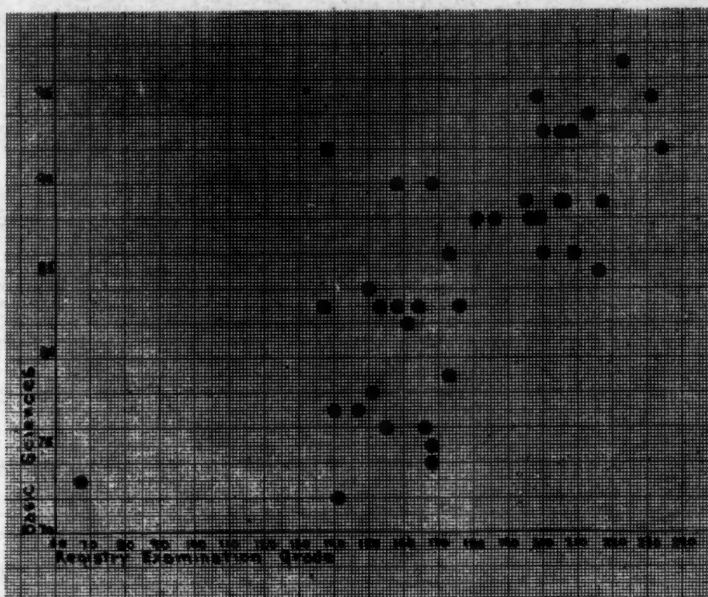


Chart 2. — Relation of the school grade in basic sciences to the Registry examination grade.

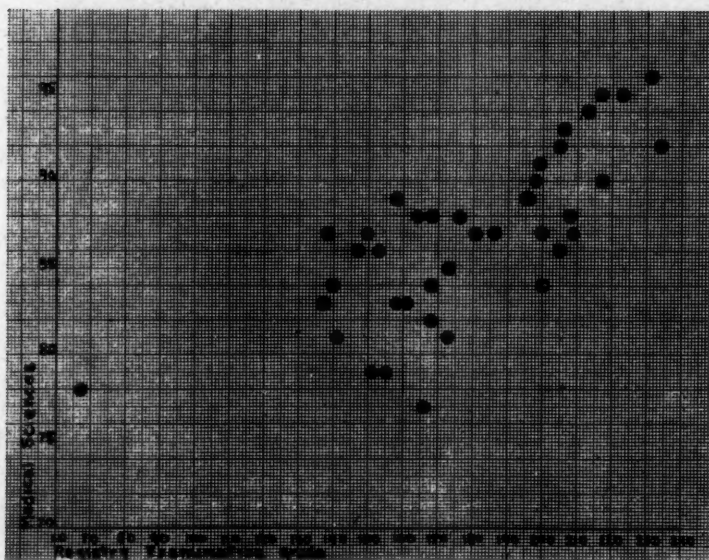


Chart 3. — Relation of the school grade in medical sciences to the Registry examination.

The next four spot diagrams illustrate the points discussed. There is a much closer relationship between success in the basic and medical sciences and the Registry score than between proficiency in technical subjects or the acquisition of practical skills and the Registry score. This may be explained in one of two ways: Either technical subjects were poorly taught or the Registry examination gives them relatively less weight than the basic and

medical sciences. However, since school grades in technical subjects failed to differentiate the superior from the inferior student with any degree of precision, it is difficult to suppose that the better correlation of the Registry

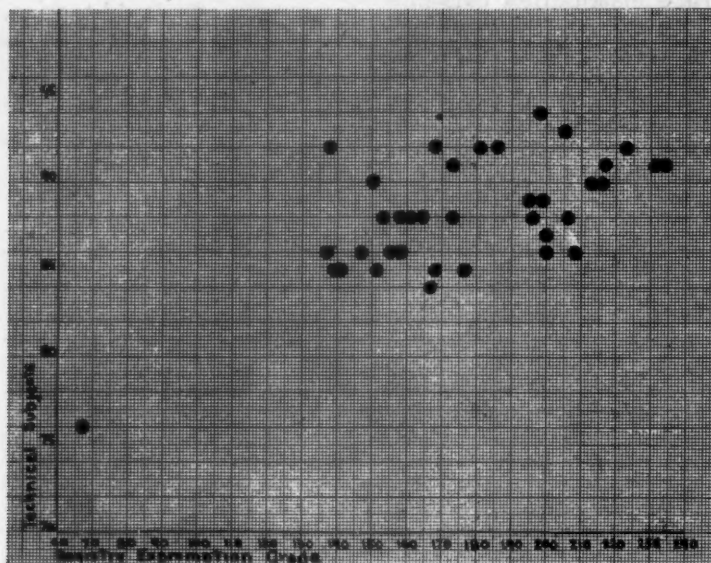


Chart 4. — Relation of the school grade in technical subjects to the Registry examination grade.

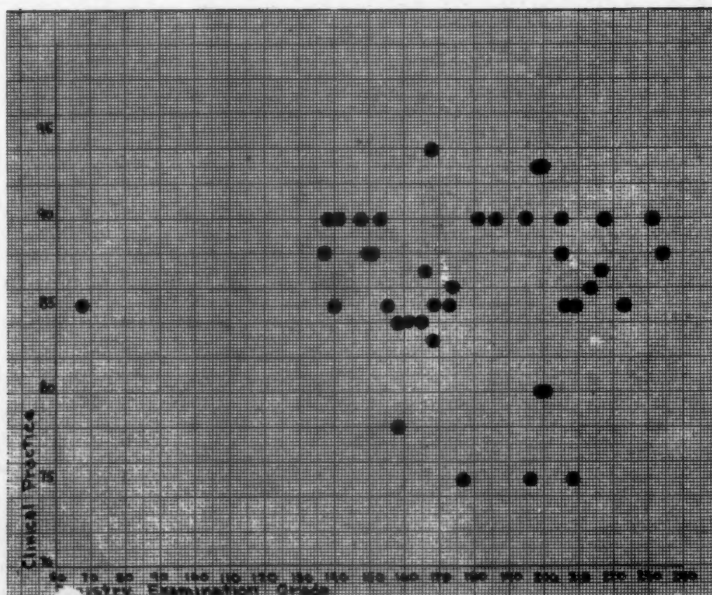


Chart 5. — Relation of the school grade in clinical practice to the Registry examination grade.

score with the other theoretical subjects was due to an unfair overloading of the Registry examination with questions in the basic and medical sciences. It would be instructive to see a similar analysis made of the records of a school staffed by a better trained and, especially a more experienced group of technicians than those available as teachers at the University of Wisconsin in the fall of 1943. If Registry grades could be broken into scores received in the basic sciences, medical sciences and technical subjects, the data thus



obtained might form a potent lever for the improvement of technician training. Improper recognition of the importance of this problem by hospital and medical school administrators has meant that technicians everywhere have been making a heroic effort to train acutely needed specialists while working under conditions conducive to anything but scholarship.

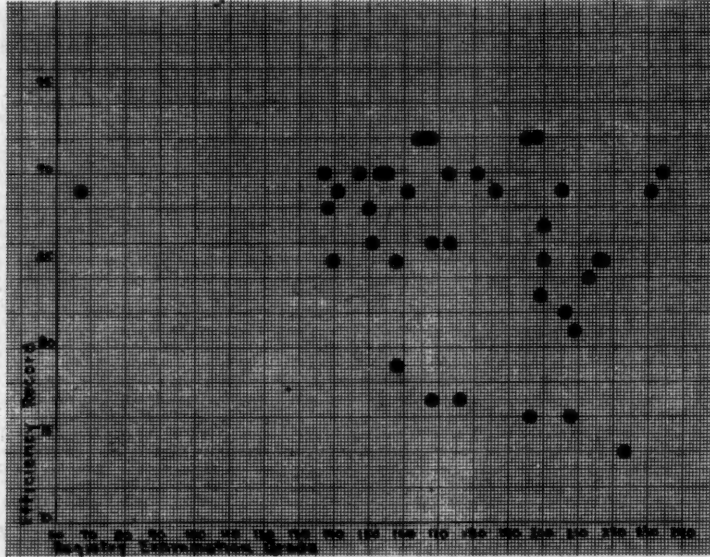


Chart 6. — Relation of the efficiency record to the Registry examination grade.

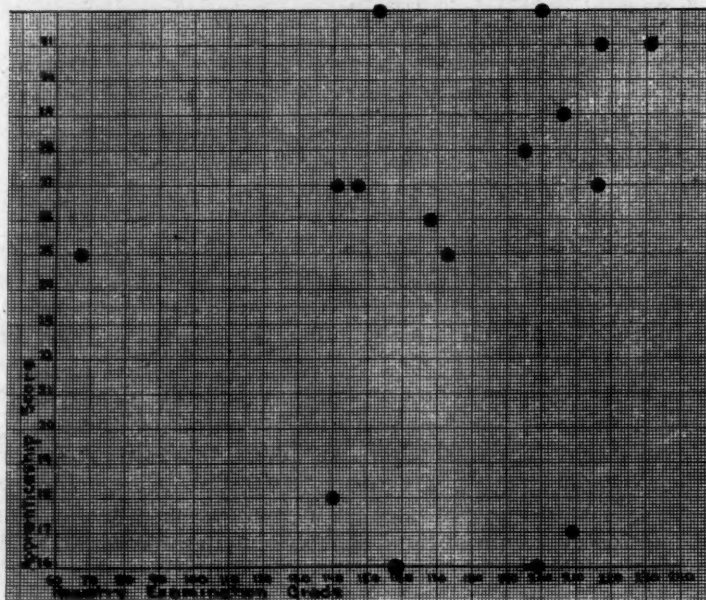


Chart 7. — Relation of the apprenticeship score to the Registry examination grade.

As might be expected, there was no obvious relation between success in the Registry examination and proficiency in craft skills. This is illustrated in the next pair of spot diagrams. The efficiency record is an arbitrary score assigned to eight factors measuring certain personality and work characteristics appearing on a report form required by The Office of the

Surgeon General. The apprenticeship score is a similar rating assigned by the field personnel. In many Army hospitals, owing to the heavy patient load and other necessities, the desirable degree of supervision exercised by the medical officer over the apprentice physical therapist is not always possible. Thus the validity of apprenticeship rating may be questionable. Exceptionally high estimates of general fitness were received from supervisory medical officers for WACS who did very poorly on the Registry examination. This may or may not have significance. A high academic standing does not necessarily imply possession of the traits and aptitudes which make for success in the application of knowledge to the treatment of the patient, but

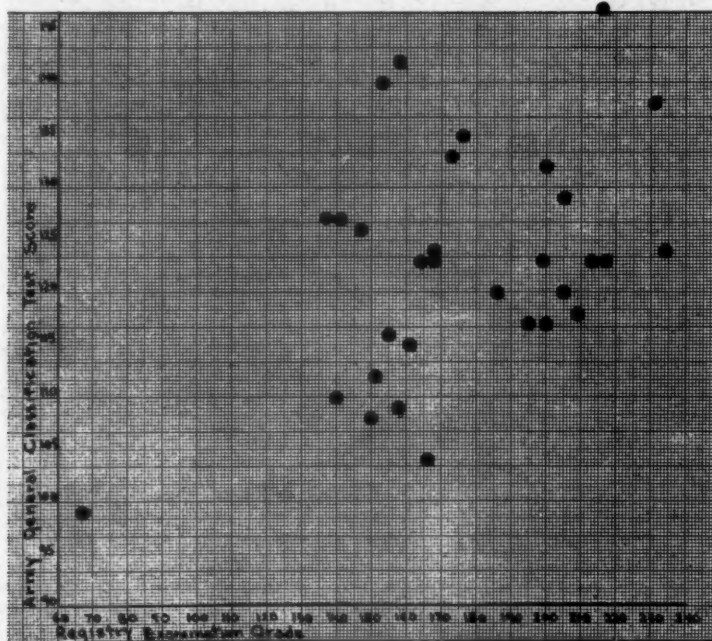


Chart 8. — Relation of the score on the Army general classification test to the Registry examination grade.

neither is stupidity a necessary correlary to clinical success. The fact remains that no valid and reliable tests exist by which to measure the behavior of trainees in the jobs for which they have been prepared or to evaluate their ability to work effectively under the stress of Army hospital or combat conditions.

Two criteria besides the school grade may be utilized to test the validity of the Registry examination. The most interesting of these is the Army General Classification Test, which is an index of ability to learn. The points on the last spot diagram are widely scattered. The evidence suggests that an average learner may through sheer persistence achieve a fairly good score on the Registry examination. The probability of ranking high is exceedingly poor. On the other hand, a very rapid learner does not necessarily do well on the Registry examination.

The highest Registry score won by a Wisconsin student was earned by a WAC with an AGCT grade not above the average for the group as a whole. Although she ranked on the Registry examination with the highest 3 or 4 per cent in the country, she had done only moderately well in her previous university work and never obtained a grade above C in the field of her major. In contrast, one of the two students who got an E in the Registry examination on the first attempt and a D— on the second had never failed

a college course and had one of the consistently highest previous school records of any student in our two groups. These aberrant cases led to a careful study of all transcripts. If the Registry examination is a valid and reliable measure of proficiency in a highly academic training program, it should reflect with reasonable fidelity the previous scholastic standing of the student. Good correlation between these variables would be presumptive evidence of validity and would further afford assurance to those responsible for training schools that the level of teaching in force compares favorably with that to which the student was formerly exposed.

For purposes of comparison and summary, table 2 presents all the avail-

TABLE 2. — *Summary of Criteria and Previous Education of Forty Students Trained at the University of Wisconsin in the WAC Emergency Course*

Preliminary Training, Years	Field of Specialization	Grade Point Undergraduate	Average Graduate	Registry Examination Score	AGCT Grade	School Grade
5	Elementary education	1.78	1.83	144 (D—)	127 (B+)	82 (C )
3	Physical education	2.09		206 (B )		88 (B )
4	Physical education	1.62		181 (C )		90 (B+)
5	Mathematics	1.93	2.55	198 (B )		94 (A )
4	Elementary education	1.82		173 (C )	133 (A—)	84 (C+)
2	Premedical course	.93		205 (B )	129 (B+)	90 (B+)
5	Mathematics	1.88	2.28	153 (D )	140 (A )	87 (B )
5	Physical education	1.47	1.65	168 (C )		91 (B+)
6	Physical science		2.72	223 (A—)		93 (A )
4	English	1.80		209 (B )	118 (B )	86 (B—)
5	Home economics	1.10	2.08	150 (D )	108 (C+)	88 (B )
2	Prenursing	.97		200 (B )	117 (B )	85 (B—)
4	Biology	1.66		186 (C )	120 (B )	90 (B+)
4	Home economics	.90		155 (D )	116 (B )	82 (C+)
4	Biology	1.89		199 (B )	123 (B )	88 (B )
2	Biology	1.49		168 (C )	124 (B )	81 (C )
3	Journalism	1.01		168 (C )	123 (B )	82 (C+)
3	Premedical course	1.40		208 (B )		86 (B )
4	Education	1.96		217 (A )	123 (B )	90 (B+)
4	Physical education	1.38		176 (C )	125 (A )	83 (C+)
4	Education	1.13		140 (D—)	110 (B—)	83 (C+)
4	Bacteriology	1.31		234 (A )	124 (B )	91 (B+)
4	Physical education	1.81		138 (E )		91 (B+)
4	Education	2.66		231 (A )	138 (A )	93 (A )
3	Biology			200 (B )	132 (A—)	89 (B )
2	Languages and sciences	1.45		196 (B )		86 (B—)
3	Education	1.09		164 (C )	123 (B )	86 (B—)
4	Biology	1.82		158 (C—)	142 (A )	88 (B )
4	Physical education	1.18		158 (C )	109 (C+)	84 (C+)
4	Languages and sciences	1.26		67 (F )	99 (C )	77 (D+)
3	Physical education	2.48		205 (B )	120 (B )	92 (B+)
4	Secretarial science	2.68		216 (A )	147 (A+)	89 (B )
4	Home economics	2.17		173 (C )		88 (B )
4	Physical education	.88		151 (D )	112 (B—)	83 (C+)
4	Physical education	.99		166 (C )	104 (C )	81 (C )
4	Education	1.20		161 (C—)	115 (B )	85 (B—)
5	Classics	2.88		213 (B )	123 (B )	91 (B+)
4	Physical education	2.17		195 (B )	117 (B )	89 (B )
4	Biological education	2.14		137 (E )	127 (B+)	85 (B—)

able criteria along with information concerning the number of years of prerequisite college training and the field of previous academic specialization.

There is nothing in the evidence to indicate significant superiority on the part of the student with the richest educational background. Nor is there anything to indicate that a major in physical education qualifies one better for mastery of the didactic material in the physical therapy training program than specialization in the social sciences or the humanities. The sample is too small for unequivocal answers to questions impinging on tradi-



tional views concerning entrance requirements, but the records now on file in the office of the registrar might yield a harvest of interesting information if subjected to an analysis similar to this one. It cannot be denied that data exist from the study of which we might erect more rational concepts of the level of the training programs we sponsor and their relation to entrance requirements. Enough data should also be on hand to demonstrate whether there is any significant difference in knowledge acquired by students in six, nine, and twelve month courses. If a two year junior college student enrolled in a six month emergency course assimilates as much knowledge about physical therapy and its supporting basic and medical sciences as the university graduate taking a twelve month regular course, this should be a challenge to our traditional thinking. Perhaps we have been offering the graduates of our universities a curriculum pitched to the intellectual attainments of the junior college student.

The Army has demonstrated that the essentials of subject matter in a variety of technical fields can be taught effectively by new methods which drastically shorten the learning period. It has demonstrated that when the premium on specialized knowledge is high, the will to acquire it is readily aroused, irrespective of the hard work and long hours necessary to attain the objective. We would be short sighted indeed if we failed to study the pedagogical experiments of the war, for the thoughtful may cull from experiences like the one herein reported much that can be utilized in a revitalized scheme of peacetime technician training.

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# THE CHALLENGE OF CRUTCHES

## II. Crutch-Walking: Muscular Demands and Preparation

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Standing erect and advancing forward on two extremities instead of the quadruped's four impose the double penalty of having to hold and to balance a much greater height and weight.

In order to perform such feats as standing upright and walking alone, as well as walking on crutches, special muscular development is needed.

### Muscular Demands of Standing Erect, Walking Without Crutches and Walking With Crutches

A. *Standing Erect.* — The requirements for standing erect have been picturesquely described by Lovett:<sup>1</sup>

If a cadaver is stood upright on its feet, the knees flex and the body crumples down on the floor. If the knees are held rigid by the application of splints to hold the knees extended, and if the cadaver is steadied in the upright position by the pelvis, the trunk falls forward. . . . If the knees are prevented from flexing by splints, the erect position are the quadriceps extensor femoris and the gluteus maximus. muscles are strong enough to hold the trunk from falling forward, that is, if they can hold the trunk extended on the legs. The two muscles most necessary to maintain the erect position are the quadriceps extensor femoris and the gluteus maximus.

In order to avoid the age-old disagreements on muscle function it is suggested that the last sentence be revised to read: "The two muscle groups most necessary to maintain the erect position are the muscle groups holding the legs extended on the thighs and those holding the thighs extended on the trunk."

B. *Walking.* — Walking involves standing erect and advancing one leg forward as the weight of the body is held on the other. The weight is then transferred to the first leg as a step is made with the second. The chief muscle groups used are:

1. The extensors of the legs to straighten the knees and keep them from buckling when weight is taken on them.
2. The extensors of the thighs to keep the trunk from folding up in front.
3. The abdominal muscles to keep the pelvis from tilting forward.
4. The flexors of the thighs or the muscles of the lower part of the back and the abdominal muscles, to get the thighs forward in taking steps.

C. *Crutch Walking.* — When pathologic conditions are such that these muscle groups cannot act together to allow walking, then mechanical aids such as crutches are needed, together with the assistance from muscle groups of the upper extremities and trunk.

Walking with crutches involves:

1. Standing as erect as possible by holding a crutch under each arm.
2. Grasping the cross pieces with fingers and thumbs.

EDITOR'S NOTE: Subsequent articles in this series will also appear in the ARCHIVES.

1. Lovett, Robert W.: The Tripod Method of Walking with Crutches, J. A. M. A. 74:1306 (May 8) 1920.

3. Straightening the elbows to allow the hands to support most of the weight of the body.
4. Moving the crutches forward as needed.
5. At least one straight knee, braced or fixed by artificial or surgical fusion, to maintain the weight of all or part of the body erect during progression.

The body is propelled forward either by advancing the extremities separately with the aid of the crutches for support or by rocking backward and forward between crutches and feet.

It is possible to walk on crutches with little muscle power, as explained by Lovett:<sup>1</sup>

Any intelligent patient with flaccid paralysis below the waist, with one good arm and one arm good enough to hold a crutch, can be taught to walk by the tripod method, and to get up and down out of a chair unaided, provided contraction deformities are not present, or have been removed by operation.

Wilhelmine Wright<sup>2</sup> said:

If a patient has normal neck muscles and sufficient strength in his fingers to grasp the crutches, with just enough power in the anterior deltoids or pectorals to swing the crutches forward, he can walk, although his body and both legs be totally paralyzed. With legs stiffened by braces from hip to foot and body held by a corset he is put on his feet and hung up on the top of his crutches, so that his feet form one point and his crutches two points of a tripod. His hips must be extended until they lock. Once he has gained his balance in this position walking consists in thrusting the head forward with the strong neck muscles until its weight upsets the balance of the body forward and the feet are dragged along the floor toward the crutches. The head must then be thrown backward, so that the weight of the body is lifted for a moment from the crutches and they can be swung forward. The whole mode of progression is a sort of rocking backwards and forwards between crutches and feet.

Experience at the Institute for the Crippled and Disabled shows that disabled subjects can become crutch walkers with even less musculature than that described by these two authors. For instance, a young man who has no deltoid muscles and no pectoralis muscles can get his crutches forward apparently by using the long head of the biceps brachii. Nor do the neck muscles have to be entirely normal in strength. In fact, crutch walking is more a matter of the subject's will to walk than a logical outcome of his muscular power as determined by a muscle test. The so-called impossible is being accomplished daily by disabled persons determined to become independent. Their achievements are due in the last analysis to the versatility of nerve tissue, which allows new detours to be etched on it when ordinary pathways are blocked by disease or injury, thus putting into use reserve materials. It is the people who are most highly endowed intellectually who can make such use of their nervous systems.

Procedures are, of course, slow and labored, so that whatever muscle power is present or can be developed beyond this minimum will make the task of walking on crutches easier.

The muscle groups, so far as they are present or can be developed, which are important for walking without crutches are important for walking with crutches, since their strengthening may lead to eventual discard of the crutches. In addition the very fact that crutches are being contemplated indicates weakness in the lower extremities, for which the shoulder girdle and arms will be called on to compensate through the use of crutches, and so the prospective crutch walker must anticipate the necessity for carrying most of his body weight by means of his shoulder girdle and upper extremities. This can be done provided these parts are strong enough. So-called normal strength is not sufficient, since bearing the weight of the whole body on crutches is not a normal requirement of shoulder girdle and arms. The

2. Wright, Wilhelmine: Crutch-Walking as an Art, *Am. J. Surg.* 1:372 (Dec.) 1926.



subject needs to develop much more than normal strength; this should be explained to him early and carefully planned exercises to be performed regularly should be devised.

The five muscle groups needed particularly for manipulation of crutches are, in order of importance:

1. Flexors of the arms to move the crutches forward.
2. Extensors of the forearms to hold the elbows stiff, so that they do not buckle when the weight of the body is placed on the hands and when the body weight is raised from the floor.
3. Finger and thumb flexors to permit grasping the crutches.
4. Dorsiflexors of the wrist to keep the hands in the correct positions on the hand pieces.
5. Shoulder girdle depressors and downward rotators to support the body by means of the crutches when it leaves the floor.

Since the action of the shoulder girdle in crutch walking is not obvious, a brief explanation follows:

The shoulder girdle is really not a complete girdle. Although the bony part is completed in the back by muscles extending between the shoulder blades, the front part makes it more like a collar than a girdle, since the collar bones do not meet in the front but rest about an inch apart on the rib cage, where they can be felt as the two bony prominences on the front of the chest where the neck begins. The whole structure rests on top of the rib cage and moves essentially at these bony contacts, the sternoclavicular joints. It can be raised upward and it can be held down. The upper extremities move against the shoulder blades at the shoulder joints. If the shoulder girdle muscles are not strong enough to hold the shoulder girdle in place, then every time the upper extremities move, the shoulder girdle also moves, and movement is not effective. Since good use of the upper extremities depends on the shoulder girdle, the shoulder girdle muscles need to be strong.

In crutch walking, the weight of the subject must be taken by the shoulder girdle and upper extremities. If the shoulder girdle slips all around and the crutches are allowed to push it up, the subject will not be able to raise his body weight off the floor.

The demands of crutch walking are heavy. Therefore, the worst kind of an approach is to pass the subject a pair of crutches, with the words, "Now, get up and walk!" Learning to operate an automobile or an airplane and learning to play golf or to ski are not approached in this way. Like these skills, crutch walking requires instruction in the fundamentals before the first attempts at performance.

#### Preparation for Crutch Walking

A prejudice has grown up in the minds of many people, even among those who work in orthopedics, to the effect that the use of crutches represents a step backward in the subject's progress. Nothing is further from the truth. Crutches should be looked on as invaluable aids toward attaining better balance and locomotion. If a disabled person wants instruction and his walking is much below par, for instance, if he staggers, shows great instability and is able to take only a few steps before hanging onto a person or a piece of furniture, then surely crutches should be recommended, and neither the subject nor his family should be allowed to feel that these aids to walking are a disgrace. Many "hopeless cases" who had been to countless clinics and physicians are now walking on crutches by dint of arduous persuasion on the part of therapists. Crutches are a stepping stone. Often they can eventually be discarded. In any case, however, neither physician

nor therapist should give in to a subject who expects to be made to walk without the fundamentals of balance which crutch walking develops.

Preparation for crutch walking includes (1) a muscle test to discover the extent of muscular weakness, (2) an exercise program to develop strength in the muscle groups necessary for crutch walking and (3) instruction in how to stand and balance with crutches before taking any steps.

A. *Muscle Test.* — Before any exercise program can be undertaken, a muscle test following standard procedures should be given in order to obtain an inventory of the strength and weakness of the main muscle groups of the body.<sup>3</sup> The results of the test serve as a basis for exercise as well as a guide in selection of the crutch gait to be used. Hidebound reliance on these results, however, is not advisable, since it is not rare for a subject whose muscle tests indicate insufficient power to astonish every one by walking. The results of a muscle test should be consulted and used as a guide, but the subject should be given a chance, should be helped to work out methods no matter how discouraging results of the test may be.

B. *Exercise Program.* — Every one has experienced the weakness and insecurity of balance which follow even a few days in bed. When a subject is confined to bed or wheel chair, his muscles immediately start becoming weaker and smaller, and it is only a matter of days before he notices, with the greatest chagrin, the weakness and flabbiness which result from disuse. Function makes structure. If muscles are not used they naturally become smaller and weaker. Active exercise is essential to maintain and increase the strength of muscles.

In view of this weakness and flabbiness which inevitably follow inactivity, it is a mistake to instruct the subject who has been bedridden suddenly to stand erect and walk without reconditioning the muscle groups needed for standing and walking.

Generally speaking, if a subject is in bed because of a condition which will not produce an orthopedic disability, he should exercise as soon as his condition permits whether his period of confinement to bed is expected to be of short or of long duration. A group of exercises should be carefully worked out on the basis of what the condition will or will not allow. Such a group of exercises would constitute a special article and will not be discussed here.

Among patients who are going to have orthopedic disabilities, the physician or surgeon will be able to tell in advance which ones will have to use crutches when they are allowed out of bed or wheel chair.

For those who will use crutches, it is good medical practice to prescribe an exercise program for the specific muscle groups used in crutch walking. The exercises to follow are grouped as (1) bed or mat exercises, (2) wheel chair exercises, (3) mat exercises, (4) standing exercises with a bar or other support, (5) walking exercises with support other than crutches and (6) standing exercises with crutches.

Bed or mat exercises are those which can be performed either in a bed or on a mat on the floor. All exercises can be performed more easily and more accurately on the floor, where there is more space and the surface is resistant. Exercises should be performed in bed only when it is impossible to have the subject on the floor. Wheel chair exercises are those performed in a wheel chair. Mat exercises are those which can be performed only on the floor. Standing exercises with a bar or other support comprise exercises in an erect position with a bar, table or wall being used for support. Walking exercises with support other than crutches include exercises in the

3. Brunnstrom, Signe: Muscle Group Testing, *Physiotherapy Rev.* 21:3 (Jan.-Feb.) 1941.

erect position with the subject using supports such as stall bars, parallel bars, sturdy tables or beds while doing walking movements. Standing exercises with crutches are those performed in an upright position with crutches properly grasped and placed under the arms for support.

Many subjects with orthopedic disabilities are measured for their appliances and then have to wait for a long period while these are being made. During this time they cannot work, of course, in a standing position. Exercises can be done only in positions other than the upright one. Some persons would be too weak to get up and work in a standing position whether or not their appliances were ready. For such persons exercises in an easier position are necessary for preliminary strengthening. It is obvious that the closer the body is to the floor and the larger the base for working, the easier it is to learn to move and control it. Therefore, regardless of appliances, it is always advisable to exercise first in a lying position, then sitting, then in a crawling, a kneeling and finally a standing position.

The exercise scheme which follows is by no means exhaustive but rather is suggestive. It includes simple exercises for the more severely disabled, as well as difficult ones, such as "push-up" exercises. A selection should be made according to the degree of disability of the subject.

An attempt has been made to indicate the number of times an exercise should be repeated and, in the case of bed or mat exercises, how often each day. These are arbitrary suggestions. If the subject cannot perform the exercise unaided, then, of course, the number of practice periods would have to depend on those in attendance.

Each exercise has been given a number and a name, so that they can be cut out, pasted on cards and filed in a clinic or gymnasium for quick reference. Such a card file is valuable, and additions can be made easily.

### 1. Bed or Mat Exercises

#### *Bed or Mat Exercise No. 1. — Flexion of the Arms.*

Purpose: To strengthen the flexors of the arms preparatory to lifting and moving crutches forward.

Equipment: Bed or mat.

Position: Supine, arms at sides.

Instructions: Raise arms, elbows stiff, till they point to the ceiling. Lower slowly. Relax, rest. *Repeat ten times on the hour.* This exercise may be made more difficult by placing objects of increasing weight in the hands.

#### *Bed or Mat Exercise No. 2. — Extension of the Forearms.*

Purpose: To strengthen the extensors of the forearms preparatory to straightening the elbows and taking the body weight on the hands while on crutches.

Equipment: Bed or mat.

Position: Supine.

Instructions: Come to a sitting position by bending the elbows and pushing the hands onto the bed or mat in such a way as to raise the body by straightening the elbows. Relax, rest. *Repeat three times on the hour.*

#### *Bed or Mat Exercise No. 3. — Prone Pushup.*

Purpose: To strengthen the extensors of the forearms preparatory to straightening the elbows and taking the body weight on the hands while on crutches.

Equipment: Bed or mat.

Position: Prone.

Instructions: Push the body off the bed or mat by pushing down on the hands and straightening the elbows. Hold for a count of ten, then slowly allow the body to return to the bed or mat by bending the elbows gradually. Relax, rest. *Repeat five times on the hour.*

#### *Bed or Mat Exercise No. 4. — Seated Pushup.*

Purpose: To strengthen the extensors of the forearms, dorsiflexors of the wrists, shoulder girdle depressors and shoulder girdle downward rotators, preparatory to



keeping the elbows straight, maintaining a correct hand position and keeping the shoulder girdle down while using crutches.

Equipment: Bed or mat.

Position: Sitting, arms at sides, palms flat on bed or mat, fingers pointing forward.

Instructions: Raise the body off the bed or mat by keeping the shoulder girdle down and straightening the elbows. Relax, rest. *Repeat three times on the hour.* If the upper extremities are short in comparison with the trunk, then sand bags or books may be placed under the hands. If the arms are long in comparison with the trunk, a hard pillow under the buttocks may be used to make up the difference.

*Bed or Mat Exercise No. 5. — Grip Exercise.*

Purpose: To strengthen the finger and thumb flexors for grasping the crutches.

Equipment: Two hand grippers.

Position: Sitting.

Instructions: Place one gripper in each hand. Alternately squeeze one, then the other, as hard as possible. Relax, rest. *Repeat fifty times three times daily.* Two rubber balls can be used to achieve a similar purpose. Hardware clamps, such as those used to clamp lamp devices securely to a shelf or wall may also be used.

## 2. Wheel Chair Exercises

Transfer of the subject from bed to wheel chair should be an early matter of concern and study. The procedure can be made a beneficial exercise, and the subject needs help in finding a way of carrying it out by himself. Since this involves moving sideways, a preparatory exercise is moving sideways on a mat (see mat exercise No. 5). Such an exercise as well as the activity itself brings into use the muscles needed for crutch-walking.

Crutches may be attached to wheel chairs or walkers so that the subject can become accustomed to the feel of the crutches under his arms. It is necessary to teach him how to keep his shoulder girdle strongly depressed as he will have to do when he stands and walks with crutches.

*Wheel Chair Exercise No. 1. — Seated Pushup.*

Purpose: To strengthen the shoulder girdle muscles and the extensors of the forearms preparatory to holding down the shoulder girdle, straightening the elbows and maintaining a correct hand position while using crutches.

Equipment: Wheel chair.

Position: Sitting.

Instructions: Grip both arms of the wheel chair. Keeping the shoulder girdle held down, straighten the arms and raise the body out of the seat of the wheel chair. Slowly sit down, relax, rest. *Repeat ten times on the hour.*

*Wheel Chair Exercise No. 2. — Chinning Exercise.*

Purpose: To strengthen the shoulder girdle muscles preparatory to keeping the shoulder girdle down while controlling weight.

Equipment: Doorway gym bar screwed in between the door jambs as high as possible and yet within reach from a wheel chair sitting position.

Position: Sitting in wheel chair.

Instructions: Grasp the bar with both hands. Keeping the shoulder girdle down, raise the body out of the wheel chair. Lower body slowly into wheel chair. Relax, rest. *Repeat ten times on the hour.*

"Chinning," which means bending the arms and raising the body upward, may also be performed. This is a good shoulder girdle exercise only if the shoulder girdle is held down firmly throughout it. As far as developing the bending muscles of the elbow is concerned, it must be remembered that, although this is a good exercise, the extensors of the forearms and not the flexors are the muscles which play the important role in crutch walking.

*Wheel Chair Exercise No. 3. — Arm Walking on Parallel Bars.*

Purpose: To strengthen the flexors of the arms, extensors of the forearms, dorsi-flexors of the hands and shoulder girdle muscles preparatory to maintaining the most efficient control of the body by the arms while progressing.

Equipment: Parallel bars.

Position: Suspended erect between parallel bars, weight supported on hands, elbows straight, shoulder girdle down.

Instructions: Wheel yourself in between the parallel bars, grasp the bars and hoist your body to the position described. Progress forward through the bars, raising one hand and moving it forward and then the other. The arms should be kept straight at the elbow and the shoulder girdle held down. Proceed the full length of bars forward, then backward. Relax, rest. *Perform once in each direction once a day.*

The advantage of chinning and parallel bar exercises is that the body takes a fully aligned position, giving gravity a chance to lengthen it still more, and the extensor muscles of the thighs can take a shortened position in contrast to the stretched position assumed in the wheel chair or half-sitting position in bed.

### 3. Mat Exercises

Transference from wheel chair onto mat is an important step for all subjects who can benefit by floor exercises. A slowly descending ramp from wheel chair to mat should be made out of any furniture which is handy, such as progressively lower stools and cushions. The ramp may be covered with a blanket or, better, a slippery mat or oilcloth. The subject then pushes himself down onto the mat from the wheel chair, using the crutch-walking muscles. After the mat work has been completed, he should ascend by the same route into his wheel chair.

*Mat Exercise No. 1. — Crutch Raising in Supine Position.*

Purpose: To learn to lift and control crutches forward.

Equipment: Extension crutches adjusted to fit subject.

Position: Supine, legs extended, arms at sides, crutches under arms and grasped with fingers.

Instructions: Grasp the crutches and alternately raise them off the floor as far as possible overhead, then slowly bring them back into place. Relax, rest. *Repeat ten times on each side. Repeat this exercise, raising the two crutches simultaneously. Perform ten times.*

*Mat Exercise No. 2. — Pushing Against the Wall in Supine Position.*

Purpose: To learn to exert pressure on crutches against the wall preparatory to pushing crutches down on the floor.

Equipment: Extension crutches adjusted to fit subject.

Position: Supine, legs extended, arms at sides, crutches under arms and grasped with fingers. The subject should be placed with his head away from the wall and his feet resting against it, so that with a crutch held in each hand the rubber crutch tip will touch the wall. Thus, the subject will be in exactly the same position in relation to crutches and wall in a supine position as he would be in relation to the floor in a standing position.

Instructions: Grasp the crutches, raise them and place them both against the wall, pressing hard. The instructor may place a piece of cardboard between the wall and the crutch bottoms and judge the strength of the pressure being exerted by trying to free the piece of cardboard. *Repeat ten times. Relax, rest.*

*Mat Exercise No. 3. — Walking Up the Wall in Supine Position.*

Purpose: To learn to press against the wall and take steps up the wall, using it as if it were the floor, preparatory to sitting and standing exercises with crutches.

Equipment: Extension crutches adjusted to fit subject.

Position: Supine, legs extended, arms at sides, crutches under arms, with the hands grasping the arm pieces. The subject should be placed with his head away from the wall and his feet resting against the wall in such a position that with a crutch held in each hand the rubber crutch tip will touch the wall. Thus the subject will be in exactly the same position in relation to crutches and wall in a supine position as he will be in relation to the floor in a standing position.

Instructions: Grasping the crutches alternately, raise them, placing first one a little higher on the wall and then the other. In other words, take steps with the crutches upward along the wall until you are in a sitting position. Reverse the procedure until you are back again in your initial position. *Repeat ten times. Rest, relax.*

*Mat Exercise No. 4. — Crutch Raising in Prone Position.*

Purpose: To learn to lift and control the crutches backward.

Equipment: Extension crutches adjusted to fit subject.

Position: Prone, legs extended, arms at sides, crutches under arms and grasped with fingers.

Instructions: Grasp crutches and raise them alternately to the ceiling as high as possible. *Perform ten times, five times on each side.* Rest, relax. Repeat the exercise raising both crutches at the same time. *Perform ten times.*

*Mat Exercise No. 5. — Walking on the Hands in Sitting Position.*

Purpose: To strengthen the extensors of the forearms, dorsiflexors of the wrists, shoulder girdle depressors and downward rotators preparatory to using these muscle groups for crutch walking.

Equipment: Mat.

Position: Sitting, legs extended straight in front of body, arms at sides, palms flat on mat, fingers pointing forward.

Instructions: Push down on the hands, keeping the shoulder girdle down and the elbows stiff. Raise the body off the floor and advance it forward, legs stiff. Relax, rest. Continue length of mat or floor space. Relax, rest. *Perform three times forward, three times backward and three times to each side.* The subject should be allowed to arrange his legs by using his hands or feet whenever necessary.

*Mat Exercise No. 6. — Shifting the Body Weight on Crutches in Sitting Position.*

Purpose: To strengthen the extensors of the forearms, dorsiflexors of the wrists, shoulder girdle depressors and downward rotators preparatory to shifting the body weight on crutches in a standing position.

Equipment: One pair of crutches, sawed off just below the hand pieces. These short crutches should have rubber caps at the bottom, since otherwise they are sure to spoil the mat or floor. The way to measure for them is to have the subject sit against a wall as straight as he can, with his buttocks against the wall and his body and legs making an angle as near 90 degrees as possible. The head should be up and the shoulder girdle and arms relaxed. The distance from the armpit to the floor is the proper measurement to take. Just as in measuring for crutches to be used in a standing position, this measurement is to correspond to the distance from the middle of the concave shoulder piece, including the rubber top, down to the bottom of the crutches, including the rubber caps. The hand pieces should be measured in exactly the same way as for crutches for use in a standing position, that is, by placing them at such a level that the shoulder girdle can be relaxed and the hands strongly dorsiflexed on the hand pieces, with an angle at the elbow of about 30 degrees with the vertical. If the subject has extremely long arms in relation to the trunk, and, therefore, the bend at the elbow must be considerable, he may increase the height of his trunk by padding the buttocks. This difficulty would not be experienced by persons with arms which are short in relation to the trunk. It is believed that as experience grows in the use of these short crutches in a sitting position, many variations of short-crutch exercises will develop.

Position: Sitting, legs extended straight in front of body, short crutches under arms, hands grasping hand bars.

Instructions: Sway from side to side, first taking the weight as much as possible on one crutch while freeing the other, and then repeating to the other side, being careful of good body alignment and finishing with the weight taken evenly on both hands. *Repeat twelve times, six times in each direction.* Relax, rest.

*Mat Exercise No. 7. — Pushing Down on Crutches and Taking Weight on Hands in Sitting Position.*

Purpose: To strengthen the extensors of the forearms, dorsiflexors of the wrists, shoulder girdle depressors and downward rotators preparatory to taking the body weight on the hands while using crutches in a standing position.

Equipment: One pair of short crutches. (See equipment, mat exercise No. 6).

Position: Sitting, legs extended straight in front of body, short crutches under arms, hands grasping hand bars.

Instructions: With the weight on the hands and keeping the shoulder girdle held down, raise the body from the floor by straightening the elbows. Slowly lower the body into place. Relax, rest. *Repeat ten times, each time trying to hold the body off the floor a little longer.*

*Mat Exercise No. 8. — Lifting Both Crutches from the Floor and Replacing Them.*

Purpose: To learn to raise both crutches from the floor and replace them preparatory to doing this in the standing position.

Equipment: One pair of short crutches. (See equipment, mat exercise No. 6).

Position: Sitting, legs extended straight in front of body, short crutches under arms, hands grasping hand bars.

Instructions: Raise the crutches from the floor and put them down quickly. *Repeat ten times.* Relax, rest.

*Mat Exercise No. 9. — Walking on Crutches in Sitting Position.*

Purpose: To strengthen the extensors of the forearms, dorsiflexors of the wrists,



shoulder girdle depressors and downward rotators preparatory to walking with crutches in the standing position.

Equipment: One pair of short crutches.

Position: Sitting, legs extended straight in front of body, short crutches under arms, hands grasping hand bars.

Instructions: Proceed to walk by pushing down on the crutches, straightening the elbows and raising the body off the floor. While the body is in the air push it forward before it comes down on the floor again. *Perform ten such steps backward and ten forward. Relax, rest.*

*Mat Exercise No. 10. — Coming to a Four Legged Position.*

Purpose: To strengthen the flexors of the arms, extensors of the forearms and dorsiflexors of the hands preparatory to using these muscle groups for crutch-walking.

Equipment: Mat.

Position: Prone, both arms straight overhead, knees about 4 inches apart.

Instructions: Draw the hands downward, allowing the elbows to bend until it is necessary for the body to be raised upward. Keep moving backward until the knees bend to a right angle with the thighs and the position becomes that of being on hands and knees. Reverse the procedure. Relax, rest. *Repeat three times once a day.*

*Mat Exercise No. 11. — Crawling.*

Purpose: To strengthen the flexors of the arms, extensors of the forearms and dorsiflexors of the hands preparatory to using these muscle groups for crutch-walking.

Equipment: Mat.

Position: Four legged on hands and knees, joints all well aligned.

Instructions: Crawl forward by placing one hand and the opposite knee forward at the same time. Crawl backward. Crawl in a circle. Crawl in a circle in the opposite direction. Use the extent of floor space available. *Perform routine once a day.* This exercise may be varied to require the hand and knee on the same side to be placed on the mat simultaneously, as in a camel's walk. An easier version is to move one extremity at a time.

#### 4. Standing Exercises With a Bar or Other Support

The following exercise has been included for the use of subjects who cannot stand unless the legs are braced in some way. Since standing in braces is a new experience, time should be spent in getting used to the feeling of them and learning how to manipulate the legs when they are encased in supporting but restricting metal.

*Standing Exercise. — Learning Standing Balance.*

Purpose: To learn to stand, shift weight and maintain balance in an upright position with braces, using support.

Equipment: Doorway gym bar placed at shoulder height.

Position: Sitting in wheel chair.

Instructions: Lock both braces, grip the bar with both hands and pull the body out of the wheel chair to a standing position. Experiment with standing balance as follows: Stand up straight far enough away from the bar so that the elbows are straight. Shift weight from one foot to the other. Move the feet forward, backward and to the side. Pay attention to good posture. Use mirrors when possible. Try to learn to know when weight is evenly distributed between the feet and when it is being held more on one foot than on the other. *Practice five times daily for ten minute periods.*

#### 5. Walking Exercises With Support Other Than Crutches

As a last step before learning to manipulate crutches in a standing position, the subject should have walking exercises while holding onto objects. If stall bars or parallel bars are available, these may be used to great advantage for many standing and walking exercises. If bars are not at hand, two iron beds may be placed foot to foot with space between in which the subject can walk, or two long steady tables may be used in a similar manner.

*Walking Exercise No. 1. — Walking Forward and Backward Between Parallel Bars.*

Purpose: To stand and walk while holding on and to learn crutch-walking movements of four point and two point alternate crutch gaits.

Equipment: Parallel bars.

**Position:** Standing upright between parallel bars, hands resting on bars.

**Instructions:** Move your right hand forward on the bar, next your left foot on the floor, then your left hand and finally your right foot. Proceed the full length of the bars forward, then go backward. Relax, rest. *Perform twice each way daily.*

**Walking Exercise No. 2.**—Swinging Forward and Backward Between Parallel Bars.

**Purpose:** To learn to stand and swing the body through by straightening elbows and lifting body on hands preliminary to swinging-through crutch gait.

**Equipment:** Parallel bars.

**Position:** Standing upright between parallel bars, hands resting on bars.

**Instructions:** With the shoulder girdle held firmly down, push down on the bars, taking the weight of the body on the hands and straightening the elbows. Swing the body through. Advance the hands quickly, place them on the bars beside the body and swing through again. Proceed the full length of the bars forward, then backward. Relax, rest. *Perform twice each way daily.*

## 6. Standing Exercises With Crutches

By now the subject has had exercises in bed or on a mat and in a wheel chair for some time. He has also tried balancing in a standing position with a bar to support him. He must next get the feel of crutches under his arms in a standing position. He is placed again a wall in a standing position with the crutches under his arms.

The correct crutch stance is a position in which the head is up straight and tall and the pelvis is held as much as possible over the feet. The crutches are placed about 4 inches in front of the subject and about 4 inches to each side, allowing a large base from which to work. The subject takes his weight mainly on his hands. The elbows are slightly bent. The shoulders are down and not hunched, and the crutches just clear the armpits, so that a minimum of weight is taken by the shoulders. The crutches lean against the ribs and are grasped there by the muscles that draw the arms toward the body.

The disability of the subject may make such an ideal position on crutches impossible. If he has no use of abdominal, back or hip joint muscles, the tripod position should be assumed: he stands with his weight forward from the ankles, the hips forward and the crutches ahead of him and out to each side. It is easy to see how important it is that he keep his pelvis as far in advance as possible. Having no muscles in the front to catch him if his pelvis gets behind him, he must lean as far forward as he can, since the anterior hip joint ligaments will stop his pelvis from going too far forward.

There should always be a therapist on each side of the subject and one in front of him. When he is in the center of the room, there should also be some one behind him. If the disabled person is particularly afraid, the four therapists should join hands, so that the subject knows that no matter in what direction he may start to fall, there will be some one there to stop him.

Wilhelmine Wright's<sup>2</sup> remarks on assistance to the crutch walker are as follows:

The safety of the patient should be guarded at every moment while he is learning to walk, but his freedom of independent motion should not be interfered with. He must have absolute confidence in the strength and watchfulness of the instructor. This can scarcely be the case if the instruction is given by a member of the family instead of a trained and experienced person. In teaching helpless patients to walk it is my practice to have one of my assistants clasp hands with me around the patient, so that which ever way he falls he may be sure of being caught. As he moves, we move with him, but never touch him unless necessary.

Sometimes in teaching a crutch gait or exercise with crutches it is found that the subject is not able to do any of the movements. In that case he is put through the motions as in a passive exercise. This means that a thera-

pist holds and moves the subject while another moves the crutches as the instructions are explained. In some cases the therapist needs only to stand in front of the subject and to give the crutches an initial impetus by pulling them forward at the right time.

When the subject is standing erect he has four points of support. He then learns how to redistribute his weight so that it is on one crutch and his two feet, leaving the other crutch free to be lifted, although it should not be lifted at first. Those learning to use crutches often fail to realize that a crutch cannot be lifted unless the weight is taken off it. It is a common experience to find people leaning with all their might on both crutches and at the same time making a tremendous effort to raise them off the ground. The subject has to learn how to make sure that his weight is definitely held on the parts not to be moved. He should be taught to regulate his weight distribution at the dictation of the teacher.

There are also persons who do not put any weight on their crutches but instead pull away from them, lean back and fall over backward. The subject must learn how to bear down on his crutches in the manner described and really feel the contact with the floor.

The time to lean on crutches with the shoulders is when resting. The hands and the trunk get tired. Therefore, the subject should be taught how to release the weight from his hands and give it all to his shoulders for a few seconds. His hands may be so tired that he needs to relax them. Raising them one at a time as high as he can to let the blood run out of them will help to relieve them. Shaking the hands may also bring relief to the overtensed muscles.

The task at hand is to learn first how to stand with crutches and shift the weight of the body and then how to move the crutches and control the weight of the body in order to maintain balance.

*Crutch Exercise No. 1. — Crutch Balancing Against the Wall.*

Purpose: To learn how to stand against the wall with crutches, transfer the weight and develop the kinesthetic sense.

Equipment: Pair of crutches.

Position: Standing against a wall with crutches under each arm and an assistant on each side to assure safety.

Instructions: Sway to one side, pushing on the crutch on that side and freeing the other crutch, but not lifting it. Repeat to the other side. When this can be accomplished, the same exercise should be practiced but the freed crutch should be lifted and replaced. As a further step the freed crutch should be not only lifted but placed at a designated point in front of the subject, after which it should be replaced again. *Perform each drill ten times to each side three times a day.*

*Crutch Exercise No. 2. — Crutch Balancing Away from Wall.*

Purpose: To learn how to stand away from the wall with crutches, transfer weight and develop the kinesthetic sense.

Equipment: Pair of crutches.

Position: Standing in center of room away from wall with crutches under each arm and an assistant on each side to assure safety.

Instructions: The same as for crutch exercise No. 1.

These exercises are elementary and should be learned by every one who plans to use crutches for an indefinite period. Other crutch-balancing exercises should follow these, but, since they differ according to the crutch gait to be used, they have been placed in the next article, entitled, "Standard Crutch Gaits and How to Teach Them."



# MEDICAL NEWS

## National Research Council

The Division of Medical Sciences of the National Research Council has been asked to continue its Committees on Military Medicine. Dr. John S. Coulter has been reappointed to serve as Chairman of the Subcommittee on Physical Therapy.

## Dr. Zeiter Accepts New Duties

The Board of Trustees of the Cleveland Clinic Foundation has appointed Dr. Walter J. Zeiter as Director of Administration. In that capacity he will have general supervision of administrative (as distinguished from medical) activities of the Clinic and the Hospital, except those relating to the financial offices. He also will serve as liaison representative between the Executive Officers of the Foundation and the various Department Heads.

Dr. Zeiter will continue as Head of the Section on Physical Medicine, and for the time being will devote part time to the Diagnostic Department.

This is a new position, created after long and careful consideration.

We are happy to announce that Dr. Zeiter will also continue his activities as Executive Director of the Congress.

## Correspondence From Our British Colleagues

Dear Dr. Kovács:

At the General Meeting, last Tuesday afternoon the 26th of June, when I gave my report, I had the honour of reading out the following message, which the Association has asked me to forward to you:

The Council and Members of the British Association of Physical Medicine held their annual meeting on Tuesday, the 26th of June, at the Medical Society of London.

It was unanimously agreed that the Association should send friendly greetings to the American Congress of Physical Medicine. The Council has followed, with brotherly interest, the excellent and stimulating work done by its American Colleagues during the last year, and looks forward to the speedy fulfillment of the policy outlined in the Baruch Report. It invites and would warmly welcome to its meetings any member of the American Congress who might be visiting England and it earnestly hopes that in the near future the two Associations may meet together to exchange ideas and create new means of furthering their common aim—the prevention and treatment of sickness and the relief of suffering by physical measures.

I hope that the time will come soon, when we will be able to attend your meetings and you will be able to join us in our discussions.

Yours sincerely,

(Signed),

FRANCIS BACH, M.D.,

Chairman, Policy Committee,

British Association of Physical Medicine.

June 28, 1945.

## Mayo Clinic to Discontinue Undergraduate Course for Physical Therapists

The Mayo Clinic Section on Physical Medicine is discontinuing its undergraduate courses for physical therapists.

The Section on Physical Medicine admitted its last class of forty-five students on July 1, 1945 and it is proposed to discontinue such courses at the Mayo Clinic when this class completes its training on July 1, 1946. Undergraduate courses for physical therapists will be continued at the University of Minnesota in Minneapolis under the direction of Dr. Miland Knapp and the Section on Physical Medicine at the Mayo Clinic is planning tentatively to organize graduate and refresher courses for physical therapists who have completed training in approved schools. It is hoped to inaugurate this program of graduate training in September, 1946.

In making the decision to discontinue the undergraduate courses for physical therapists, the Section on Physical Medicine at the Mayo Clinic decided that there was an adequate number of approved schools now available to continue such training in the post war period and decided also that there was a need for the development of graduate and refresher courses to provide advanced training for physical therapists returning from military work to civilian life and for civilian physical therapists who desired additional training.

Since January, 1942, the Section on Physical Medicine at the Mayo Clinic has trained or is training 436 physical therapists to fill the vacancies created by the needs of war. On July 7, 1945, the Office of the Surgeon General advised the Mayo Clinic that 112 physical therapists trained at the Mayo Clinic had been commissioned as second lieutenants in the Army Physical Therapy Corps.

## School for Physical Therapists

Albany Hospital, Albany, has established a new school for the training of physical therapists. The period of study is nine months, with a preclinical course of three months and a clinical course of six months. It consists of both didactic lectures and practical work carried on in the Albany Hospital and the Albany Medical College and affiliated institutions. The course will be given twice yearly, the first class to be admitted Sept. 12, 1945 and the second on March 13, 1946. Additional information may be obtained from Dr. John W. Ghormley, medical director of the school. Miss Catherine Graham is the technical director.

(Continued on page 530)

# ARCHIVES of PHYSICAL MEDICINE

OFFICIAL PUBLICATION AMERICAN CONGRESS OF PHYSICAL MEDICINE

## .. EDITORIALS ..

### THE NEED FOR AN APPRAISAL OF POSTURE

The word "posture" presents to most physicians a picture of the Harvard University Chart for body mechanics. There is then a transfer to individuals, judging them by these standards without a thought of the meaning of the term from a medical point of view.

There are two general ideas about posture: (1) that of the average physician, and (2) that of the physiologist. These two ideas are widely different in their scope. The average physician believes that poor posture causes many diseases, some of which it may and others which it probably does not cause. Within certain limits, poor posture probably rarely causes any concomitant disease, even backache.

Physiologists have studied the effects of posture on the various systems of the body. Most of their studies have led to the opinion that human beings are constantly fighting the forces of gravity. With the transition to the orthograde position, the center of gravity has been raised and the base on which it is supported has been narrowed. This has led to several adaptations, most of which are inadequate to meet the constant needs of the body. The result is a tendency to overcome this position by lowering the center of gravity (poor posture).

In the matter of adaptation to the upright position, some of the following physiologic facts have been discerned. The circulatory system is probably affected more than any other system. The blood pressure decreases when an individual assumes the erect position from the supine position. This decrease is in part overcome by the aortic and carotid reflexes; however, if the position is maintained quietly for several minutes, orthostatic hypotension may result. The venous return to the heart is hampered by the increased hydrostatic pressure and the heart rate is increased with a decrease in minute output. The sum total is then one of lessened blood supply to the brain with frequent spells of "fainting" or syncope. It would appear from this picture that the mechanism of adaptation is inadequate, at least for quiet standing.

With body sway and motion, these circulatory adaptations become more efficient and an individual may maintain the erect position for considerable periods without untoward effects.

To maintain posture, the proprioceptive reflexes from muscles, joints, tendons and ligaments have been augmented in man. There is a constant flow of impulses to the spinal cord from these sources and the synaptic connections in the anterior horn cells keep a constant changing muscle tonus in those muscle groups which keep one erect. It is this constant variation of afferent and efferent impulses which leads to body sway and sets up a more or less individual characteristic "sway" pattern.

There is an increase in pulmonary ventilation on assuming the upright position. This is not a compensatory increase caused by increased demand for oxygen. The concomitant increase in metabolism is considerably less than could be accounted for by the increase in respiration. To date, no one has adequately explained the economy of energy output in maintaining the orthostatic position. On the basis of the known facts of circulation,

muscular effort and respiratory increase, it would appear that the energy output would be greatly increased from that in the supine position, but experimentally the increase in the basal metabolic rate is 20 per cent or less.

On the basis of scientific research, little evidence has been gathered to defend the medical opinions of posture, except in extreme cases, such as marked scoliosis with compression of one side of the thorax. Too often, the physician looks at a patient and declares that posture is the cause of his trouble. Corrective postural exercises are prescribed and, if the condition clears up, the physician believes that the relief was due to the postural correction.

Most of the concepts of the physician regarding posture have been handed down from generation to generation without careful analysis, experimentation and proof. On the other hand, some things have been investigated scientifically. Coffey<sup>1</sup> has investigated visceroptosis and found that in about 20 per cent of men the ascending and descending colon is not completely fused with the parietal peritoneum. He expressed the opinion that most mobile kidneys, mobile cecum and general visceroptosis fall in this group and by reason of this would be primary in nature rather than secondary to poor posture.

Other investigators have had conflicting results in associating disease with posture. This conflict of opinion is brought about by inadequate methods and criteria for measuring good posture and to a greater extent by inadequate objective measures of anatomic displacement and its concomitant disease processes. Another pitfall has been the fact that too often the patient must be treated without control procedures.

It is true that there are a large number of orthopedic conditions which cause abnormal posture. Some of these can be corrected by proper physical procedures while others must be treated by the orthopedist in a variety of ways determined by the nature of the disease and the competency of the orthopedist. Concomitant symptoms and signs of disease of other systems and organs may accompany the orthopedic condition and one wonders whether these are secondary to the orthopedic condition. If they are, correction of the orthopedic problem should bring about recovery of the secondary findings. However, these accompanying signs and symptoms may be the primary causes of the orthopedic condition, in which case the correction by the orthopedist would not cause a remission of the primary disease process. There is still a third possibility; namely, that the concomitant findings are unrelated to the orthopedic condition and that both conditions should be treated to effect a recovery.

There is a general failing among physicians; namely, failure to recognize "cause and effect." Many diseases are self-limited, yet if treatment is successful the physician is too prone to assume that the patient recovered because of the treatment. It may have been in spite of the treatment. An example of this is rheumatoid arthritis, which often is recognized as being a self-limited disease. If just before a remission, it is treated by most any of the popular methods, such as physical therapy, various venoms, dietary changes, high vitamin D intake, or rest, remission may erroneously be attributed to the treatment. The treatment may be contributory to the remission or it may not; in fact, it might even retard remission in some cases. Therefore, it behooves one to be very careful lest his enthusiasm overcomes his better judgment.

One phase of posture has not been mentioned here because it is not a scientific phase. This is the social and economic factor. The subconscious impres-

1. Coffey, R. C.: Surg., Gynec. & Obst. 15:365, 1912.



sion left in the mind of an employer or business associate by an upstanding young man cannot be evaluated except in dollars and cents. However, in as much as all must make a living, the matter of posture has a significant place in our every day lives. Along with this social and economic value there is a psychologic value to the individual himself. There is a sense of self-satisfaction and "will to win" with one who has pride in his carriage. It reminds one of "Casey at the bat."

Perhaps the latter measures are more important than many of those mentioned previously. However, in the matter of posture, it would be well for one to be alert to these facts and be constantly on the lookout for scientific evidence of the beneficial effects of good posture rather than attributing powers to it that do not exist.

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### TRAINING OF PHYSICAL THERAPY TECHNICIANS

Some of the data presented in the paper "Analysis of the WAC Emergency Physical Therapy Program," now belong to history. However, the studies made on this group of students and the analysis presented are important and should be stimulating and helpful to those who arrange training programs in the future.

Undoubtedly, much valuable information relative to type of training, the amount of material that can be presented in a given time, the type of student who can be trained most easily and the prerequisites most necessary could be obtained by careful analysis of the records of all the approved schools. Comparisons could be made of the schools which have courses of varying lengths, including the emergency course and the merits of each school and each course could be determined. Apparently, nearly all the programs for special training that have been used during the war indicate that much more material can be presented to the students and assimilated by them in the limited time available than was thought to be possible previously.

The organization of approved schools and the setting of standards required that the prerequisites for admission be established. There was, at that time, however, little actual experience on which to base these standards. Now the experience of a number of years is available and especially since the war began a large group of students have been trained. Different schools have varied in ways and means by which these students have been trained and in the prerequisites required for admission. There is some variation of opinion as to what preliminary training is most beneficial to the student in the field of physical therapy. However, there is not much tangible evidence to substantiate any one opinion. Therefore, a careful analysis of past records might do much to standardize training and to assist in developing a method of selecting students. Much needs to be done by way of investigation relative to selection of students, curricula and method of presenting the subjects in the schools of physical therapy. More extensive studies similar to those presented in the article mentioned herein might be of considerable value in standardizing and improving the undergraduate and the graduate schools of physical therapy. In addition it would appear that every effort should be made to develop and use aptitude tests to assist in selection of students for these courses.

**Medical News***(Continued from page 526)***Malcolm MacEachern Award**

The Johnson and Johnson Research Foundation has created an annual award at Northwestern University consisting of a silver medal and an honorarium of \$250 to be known as the Malcolm T. MacEachern Award. The award honors Dr. MacEachern, associate director of the American College of Surgeons and director of the program in hospital administration at the school. The award was announced at a National Hospital Day celebration in the auditorium of the American College of Surgeons, May 12, simultaneously with an announcement of a five year grant of \$75,000 to the program in hospital administration, including scholarships, also from the Johnson and Johnson Research Foundation, to supplement \$15,000 granted two years ago. A renewal of scholarship grants by the American Hospital Supply Corporation was also announced. Since the program in hospital administration was started in September, 1943, 113 students coming from seventeen states have enrolled in one or more of the nine new courses offered, in addition to taking background courses in other departments of the university. An advisory committee, board of consultants and faculty consisting of authorities in the hospital field assist in formulating policies of the program, conduct the courses and demonstrations and supervise the internships required before conferring degrees. Dr. Irvin Abell, Louisville, Ky., chairman of the board of regents of the American College of Surgeons, spoke on "The Significance of National Hospital Day, 1945."

**Form Corps of Poliomyelitis Emergency Volunteers**

The National Foundation for Infantile Paralysis is organizing a nationwide program to form and train a corps of poliomyelitis emergency volunteers to assist physicians, physical therapists and nurses in areas where infantile paralysis epidemics occur. The new corps will be called "PEVS." The initial phases of the program provide only for instruction in those areas where qualified teaching personnel, institutional facilities for the care of poliomyelitis victims and actual infantile paralysis cases exist or are anticipated during the coming year. If an outbreak occurs in an area where the volunteers have not been organized and trained, the foundation will be prepared to give emergency training assistance through emergency courses. The course, designed for eight lecture and demonstration classes of two hours each, will be scheduled for local convenience.

**Polio Epidemic Aid Unit**

At the request of the National Foundation for Infantile Paralysis an Epidemic Aid Unit has

been established at Northwestern University Medical School. This unit will be on call by the Foundation to an epidemic area to organize the treatment and teach local personnel. The personnel at Northwestern consists of Dr. Emil Hauser, Dorothy Dean, Anne Prochazka and Louise Reinecke.

**WAC Training Program to Stop**

Subsequent to VE-Day, an estimate of the future requirements of medical department physical therapists indicated the advisability of curtailment of the physical therapy training program conducted by the medical department of the Army.

As a result of this decision, the training program in physical therapy for enlisted members of the Women's Army Corps will be terminated on Jan. 10, 1946, on completion of the courses currently in progress.

The Secretary of the Council on Medical Education and Hospitals of the American Medical Association has been advised that students should not be enrolled after Sept. 1, 1945, for the six months Emergency Training Courses in Physical Therapy for subsequent applicatory training in medical department installations.

**Report of Warm Springs Foundation**

During the fiscal year 1944, 543 patients received 36,549 hospital days' care at the Georgia Warm Springs Foundation, according to its annual report. Of the total, 289 received financial assistance, this group receiving 22,852 hospital days' care, or 62.52 per cent of the total hospital days' care. The average daily number of patients in residence throughout the year was 100. Newspapers reported recently that a syndicate of life insurance companies is making payments to the foundation on a \$560,000 policy taken out by the foundation in 1930 on the life of Franklin D. Roosevelt, then governor of New York. The foundation paid the premium and also was the beneficiary, it was stated.

**Physical Therapy Scholarship News**

A total of 2,196 inquiries about physical therapy training scholarships have been received by the National Foundation between March 19 and May 15, as the result of announcements of its \$1,267,600 physical therapy program.

The first scholarship award in the campaign of the National Foundation for Infantile Paralysis to recruit 1,000 persons for physical therapists was made to Miss Marjorie Katherine Ionta, North Weymouth, Mass., during a luncheon meeting at the Waldorf-Astoria, New York, May 25. Miss Ionta will study at Harvard Medical School, Boston.

## BOOK REVIEWS

**DIABETES. PRACTICAL SUGGESTIONS FOR DOCTOR AND PATIENT.** By *Edward L. Borts, A.B., M.D., F.A.C.P.*, Associate Professor of Medicine, Graduate School of Medicine, University of Pennsylvania and Chief of Medical Service B, The Lankenau Hospital, Philadelphia; Assistant Editor, *The Cyclopedia of Medicine, Surgery and Specialties*. Foreword by *George Morris Piersol, M.D.* Philadelphia. Third Edition. Cloth. Pp. 304, illustrated. Price, \$2.50. Philadelphia: F. A. Davis Company, 1944.

An intelligent understanding of the nature of diabetes enables the patient to live a long and an interesting life. The study of this disease is a fascinating one for the doctor and patient alike. The limitations imposed on the patient by his condition are important safeguards to sound body health which might, with profit, be followed by nondiabetics in the community. For the physician, a broad interest in the diabetic and his problem furnishes information in the problems of metabolism, nutrition, hygiene and prevention of disease that serve him in good stead in the community. For the physician, a broad interest in the diabetic and his problem furnishes information in the problems of metabolism, nutrition, hygiene and prevention of disease that serve him in good stead in the treatment of many other conditions.

No other disease requires so much cooperation of physician and patient as does diabetes. Also its successful management and control calls not only for sympathetic understanding between physician and patient, but in addition for effective team work of dietitians, social workers and laboratorians. All of these agencies must be coordinated and directed if the best interests of the growing army of diabetics are to be safeguarded. In order that this may be brought about, education of the patient as well as of the physician and those who must collaborate with him is essential.

This volume is a useful addition to the books that have played such a prominent part in giving patients an intelligent understanding of the cause and nature of diabetes, its diagnosis and treatment.

The author has not attempted to cover the entire field himself but has enlisted the aid of a number of specialists. There is an excellent chapter on the care of the feet by Rappaport; on surgery in diabetes by J. Montgomery Deaver; dental care by Doctor Hellwege and diet by a well trained dietitian, Sister Maude Behrman.

It is possible to give the diabetic a greater variety in the choice of foodstuffs and a more satisfactory and easily carried out diet plan. This is incorporated in this book. The chapter on insulin has been entirely rewritten in this edition because of important advances. Protamine zinc

insulin is now widely accepted as the insulin of choice for the patient who is beginning his treatment for diabetes and who has not previously taken insulin. Reference is made to the most recently developed Globin insulin, which, occasionally may be the preferable type of insulin to use.

A table showing the different diagnostic features of the more important conditions causing coma has been incorporated for the physician. A new and simplified method of testing for sugar in the urine is described which patients may use with profit; it not only shows the presence of sugar but gives an approximate estimate of the quantity.

This book is recommended to physicians, patients, dietitians and nurses who are interested in diabetes.

**TEXTBOOK OF MEDICAL TREATMENT.** By various authors. Edited by *D. M. Dunlop, B.A. (Oxon.), M.D., F.R.C.P. (Edin.), M.R.C.P. (Lond.)*, Professor of Therapeutics and Clinical Medicine, University of Edinburgh, Physician, Royal Infirmary, Edinburgh. *L. S. P. Davidson, B.A. (Camb.), M.D., F.R.C.P. (Edin.), F.R.C.P. (Lond.)*, Professor Medicine and Clinical Medicine, University of Edinburgh, Physician, Royal Infirmary, Edinburgh, Formerly Regius Professor of Medicine, University of Aberdeen and *J. W. McNee, D.S.O., D.Sc., M.D. (Glas.), F.R.C.P. (Edin.), F.R.C.P. (Lond.)*, Physician, H. M. the King in Scotland, Regius Professor of Practice of Medicine, University of Glasgow Physician, Western Infirmary, Glasgow, Consulting Physician, University College Hospital, London with a Foreword by the late Professor *A. J. Clark, B.A. (Camb.), M.D., D.P.H., F.R.C.P. (Lond.), F.R.S.* Formerly Professor of Materia Medica, University of Edinburgh. Cloth. Price, \$8. Pp. 1218. Third Edition. Baltimore: A William Wood Book, The Williams & Wilkins Company, 1944.

A new edition of this book after an interval of only two years was made necessary in view of the rapid advances in therapeutics, particularly chemotherapy. Unfortunately this new edition is already out of date in this subject now that penicillin is available for general use. The aim of this book is to provide detailed and specific instruction in the treatment and management of medical patients. In recommending the use of drugs, instead of simply mentioning the average dose, details of contraindications, unusual reactions and dangers are fully discussed. Another valuable asset is the consideration of the general management of the patient, that is details of diet, amount of rest, exercise and nursing care. Such matters are included as activity during convalescence, value of sanatoria, change of air and climate and something of the important psychologic



principles to bear in mind when dealing with patients and their relatives. This is therefore a helpful guide to the art of medical practice which is so often neglected in the average scientific treatise. Those particularly interested in physical medicine will appreciate the detail with which physical therapeutic measures are described. In the treatment of arthritic conditions, line drawings are included to illustrate appropriate exercises. Occupational therapy is also frequently mentioned. Medical students, interns and practicing physicians will find this an extremely valuable book.

#### DISEASES OF THE DIGESTIVE SYSTEM.

Edited by *Sidney A. Portis, B.S., M.D., F.A.C.P.*, Associated Professor of Medicine, University of Illinois College of Medicine. Second Edition. Cloth. Pp. 932, with 182 illustrations. Price, \$11.00. Philadelphia: Lea & Febiger, 1944.

This is the second edition of this well known book on digestive diseases. There are forty-eight contributors, each an authority in his special field who discuss the entire gastrointestinal tract, including the liver, gallbladder and the pancreas. There are chapters on the gastrointestinal manifestations of cardiovascular, renal, urologic and allergic diseases. The anatomy and physiology of the major organs are discussed by authorities. Intestinal protozoal and metazoal infestations are presented in detail.

This edition has been thoroughly revised and is well illustrated. The psychosomatic aspects of digested diseases are considered at length. The present edition may be highly commended as an advance over the previous edition. The book covers a wide scope and fills a long felt need. All in all this is an excellent book and one of the finest on the subject. It should be in the library of every physician.

#### PRACTICAL NEUROLOGICAL DIAGNOSIS.

WITH SPECIAL REFERENCE TO THE PROBLEMS OF NEUROSURGERY. By *R. Glen Spurling, M.D.*, Associate Professor of Surgery (in Charge of Neurosurgery), University of Louisville School of Medicine. Cloth. Pp. 239 with 101 figures. Third Edition. Price, \$4.00. Springfield, Ill.; Charles C. Thomas, 1944.

This is the third edition of a small monograph written primarily to present the simple principles of neurologic diagnosis. It is designed essentially for medical students and general practitioners. There is no attempt to make a glossary of symptoms and signs of all neurologic disorders. Many duplicating tests are purposely omitted and only tests which the author has found to be most useful through years of experience are presented.

The book is divided into three parts. The first section includes an outline of neurologic examinations and a discussion of general observations emphasizing important aspects relative to neurologic history and general inspection of the patient. The remainder of this part of the book is devoted to the several portions of the central nervous system; for example, the cranial nerves, cere-

brum, cerebellum, spinal cord and reflexes. Under each division there is a discussion of anatomy and physiology and the types of reaction to be expected as a result of pathologic lesions. In the chapter concerning reflexes the author discusses the technic of testing and gives a brief outline of the significance of diminished or increased reflexes.

The second section of the book deals with the spinal fluid, briefly describing the anatomy of the cerebrospinal fluid spaces, the physiology of the formation of spinal fluid and its function. The contraindication for spinal puncture is discussed. The technic for spinal punctures is carefully described. A concise outline of the cerebrospinal fluid findings in health and disease is given.

The last section of the book is devoted to roentgenologic diagnosis. The author discusses (1) ordinary films of the head and spine, (2) air studies of the brain, ventriculography, encephalography and (3) myelography. He describes technic, gives contraindications and illustrates various lesions demonstrable by roentgenologic studies.

This book is systematically outlined, well written and adequately illustrated and should be excellent for the two groups of persons for which it was written; namely, students and general practitioners. The present edition has been changed little from previous editions, except for the section on myelography which was completely revised.

THE DOCTOR'S JOB. By *Carl Binger, M.D.* Cloth. Price, \$3.00. Pp. 243. New York: W. W. Norton & Company, Inc., 1945.

This is one of the most stimulating and informative books on the present day position of medicine, written for intelligent laymen. Its author has had an unusual amount of cultural and scientific background, writes easily and with the attributes of a sincere and outspoken, yet extremely well balanced personality. Dr. Binger is a graduate of Harvard Medical School and served first with the Rockefeller Institute of Medical Research, where, incidentally, he inaugurated some of the first basic animal experimentation with diathermy; later he became Associate in Clinical Medicine first at Columbia and now at Cornell Medical College, at the same time carrying on an active medical practice of his own. His volume is the result of many years thought on the social aspects of modern medicine. The eighteen chapters of the book discuss such a variety of timely topics as "Specialties and Specialists," "The Choice of a Physician, Medical Fees and Etiquette," "Medicine and Psychoanalysis," "Psychosomatic Medicine or Mind and Body Relationships," "Allergy, Asthma and Tuberculosis," "High Blood Pressure," "The Cure and Control of Disease," "Convalescence and Chronic Disease," "The Prevention of Illness," "Office Practice, Hospitals and Outpatient Departments," "Socialized Medicine or Paying the Piper." Binger's book was the first winner of the Norton Medical Award for the writing of books on medicine and the medical profession for the layman.

It clearly demonstrates the spirit that inspires and sustains men of medicine in their work. It should be absorbing to the general reader, enlightening to patients and valuably suggestive to physicians.

**PSYCHOLOGY AND PSYCHOTHERAPY** By *William Brown*, D.M. (Oxon.), D.Sc., (Lond.), F. R. C. P. Wilde Reader in Mental Philosophy and Director of the Institute of Experimental Psychology in the Oxford University; Hon. Consulting Psychologist, Bethlem Royal Hospital. Fifth Edition. Cloth. Price, \$4.75. Pp. 223. Baltimore: Williams & Wilkins Co., 1944.

The fifth edition of this text by a distinguished British psychologist offers not only a scholarly presentation of the theory and practice of psychotherapy, but also portrays the general historical background of the subject and gives much attention to its wider implications on the domains of political science and present-day international affairs. The author is an ardent follower of Freud and his concept of "transference" and also leans heavily on some of the original German philosophers like Kant. After an introduction on the present importance of psychology and psychotherapy and the characteristics and degrees of dissociation, the theories of Freud on dreams and of the unconscious as well as those of emotion are fully discussed. Psychoneuroses of War, Psychotherapy in the Prevention and Treatment of Alcoholism, Psychology and the Adolescent, Psychological Problems of Later Life, Suggestion, Hypnotism and Faith are the topics of the subsequent chapters. The psychologic backgrounds of German History and of Hitler's hysterical tendencies, now fortunately a subject soon to be forgotten, are presented at great length in the chapters on The Psychology of Peace and War and The Psychology of Modern Germany. The final chapters of the instructive volume deal with the Relation of the Mind to Brain and with Psychical Research, The Eternal Values. This is a valuable contribution for all students of modern psychotherapy.

**CAMPING FOR CRIPPLED CHILDREN.** Editor *Harry H. Howett*, Director, Social Research, The National Society for Crippled Children and Adults, Incorporated by Committee on Camping, Ernest B. Marx; Gertrude Whitehead; Joseph E. Gembis, and Harry H. Howett. Price, \$1.00. Pp. 120. Elyria, Ohio: The National Society for Crippled Children and Adults, Incorporated, 1945.

The authors of this text recognizing the value of camping have made a study of the special problems involved in camps for crippled children. They have indicated that the special needs of handicapped children make advisable separate camps, more precautions for safety and specially selected counselors including therapists and technicians. Establishment of normal social relations as in camp is an important objective in this group of individuals so often accustomed to institutional life. As this book is intended as a practical guide to those planning such a camp the information

includes full details. For example there are included complete equipment lists, sample forms for applications, contracts, letters to parents, permission blanks, medical treatment and history sheets, muscle charts, daily schedules, camp menus for one week and many other specific suggestions. There are also numerous references at the end of each chapter. This is a valuable book, recommended for camp organizers for its practical information and also as a textbook for students in this field.

**ROSE'S FOUNDATIONS OF NUTRITION.** Revised by *Grace MacLeod*, Ph.D., Professor of Nutrition and *Clara Mae Taylor*, Ph.D., Associate Professor of Nutrition, Teachers College, Columbia University. Cloth. Pp. 594, illustrated. Price, \$3.75. Fourth Edition. New York: The Macmillan Company, 1944.

A considerable amount of reorganization is found in the revision of this well known textbook. The chapters on energy, protein, water and the minerals have been rearranged. The chapters on dietary planning have been rewritten with the object of simplifying the selection of adequate diets. The contents are divided into 19 chapters, an appendix containing 17 important tables and a complete index. At the end of each chapter there is found reading references chosen for their availability and clearness. Throughout the text some references to original investigations have been included as footnotes for the sake of those who wish to get a little more of the experimental point of view.

Mary Swartz Rose is known to all who are interested in the field of nutrition. This revision was undertaken after her death at the request of her family and incorporates many of her suggestions. The topics as presented are too familiar to any who have studied her previous works to need a detailed review. To those who are first exploring the field of nutrition this book is recommended as the best in its field. The work of those who carried out the revision is to be highly commended.

**PENICILLIN THERAPY. INCLUDING TYROTHRICIN AND OTHER ANTIBIOTIC THERAPY.** By *John A. Kolmer*, M.S., M.D., Dr. P.H., Sc. D., LL.D., L.H.D., F. A. C. P., Professor of Medicine in the School of Medicine and the School of Dentistry, Temple University; Director of the Research Institute of Cutaneous Medicine; Formerly Professor Pathology and Bacteriology, Graduate School of Medicine, University of Pennsylvania. Cloth. Pp. 302 with 22 illustrations. Price, \$5.00. New York and London: D. Appleton Century Co., 1945.

This timely publication should prove of interest to all practicing physicians. So much literature has been published in the past several years on penicillin and related substances, that the average reader of medical literature is left confused in rational interpretations of the data presented. Doctor Kolmer has excellently prepared this book and has been able to weed out from the volume



of medical literature the pertinent data known on this subject today.

Limited supplies of these valuable chemotherapeutic agents are rapidly being eliminated by mass production. However, every effort should be made to administer them in such a way that the maximal effect may be derived without wastage. The physicians employing these drugs should preserve these drugs by utilizing the known information. Such material is well outlined in this publication of 302 pages, well illustrated with photographs and tables. Any physician who is or will employ this drug or similar antibiotics should first read this book for a fuller understanding of the subject.

The opening chapter on Chemotherapeutic Compounds of Biologic Origin; Antibiotics, gives a clear picture and general considerations regarding penicillin and other antibiotics such as tyrothricin, gramicidin S and others. The book covers such subjects as the production of penicillin, methods for the detection and assay, physical and chemical properties, antimicrobial activity in vitro and vivo, pharmacology and toxicity, administration and dosage, principles of penicillin therapy, application in the treatment of staphylococcal, streptococcal, pneumococcal, meningococcal, gonococcal, clostridial disease, penicillin in the treatment of wounds and burns, in the treatment of syphilis, and other diseases where the drug has been clinically applied and significant results have been noted.

In addition to complete review of the literature on penicillin therapy, the properties and clinical applications of tyrothricin, gramicidin S, streptothricin, patulin and chlorophyll is reviewed. In the field of dentistry and oral surgery the therapeutic use of penicillin is discussed.

The developments in the various parenteral methods of administration and local applications is presented. This publication is highly recommended for all physicians.

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**PHYSICAL DEMANDS OF DAILY LIFE. AN OBJECTIVE SCALE FOR RATING THE ORTHOPEDICALLY EXCEPTIONAL.** Studies in Rehabilitation No. 1. By George G. Deaver, M.D., and Mary Eleanor Brown, M.A., Physical Therapist. Paper. Pp. 36. Price, 10 cents. New York: Institute for the Crippled and Disabled, 1945.

The Institute for the Crippled and Disabled concerns itself principally with those having serious physical disabilities, in most cases attended with other involvements. These, while less apparent often present problems of equal if not greater importance in the effort to restore the individual to the fullest physical, mental, social, vocational and economic functioning of which he is capable. This is the first of a series of published studies based on material and experience which have accrued during the twenty-seven year history of the Institute. This pamphlet presents a rating scale to determine how much an individual can perform of the acts inherent in ordinary daily living, such as locomotion and

traveling activities, self-care and hand activities. It offers a detailed rating scale blank, discusses the details of grading, gives a floor plan and orientation as to convenient equipment and finally offers an analysis of rating scale items. The use of this scale offers a useful tool to hospitals, convalescent centers, physical therapists, and educators for determining and prescribing treatment in those exceptional cases which in spite of having had routine treatment and care of long periods, cannot perform the ordinary routine tasks required in daily life.

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**AIDS TO ORTHOPEDIC SURGERY AND FRACTURES.** By I. E. Zieve, M.A. (Capetown), F. R. C. S. (Eng.); Surgical Registrar, Charing Cross Hospital; Temp. Asst. Orthopedic Surgeon to the Royal Waterloo Hospital, London. Second Edition. Cloth. Pp. 270. Price, \$1.75. London: Bailliere, Tindall & Cox, 1944.

The material in this edition is so arranged that it presents a survey of those inherent and environmental influences which are harmful to the human organism. Thus chapters one to four deal with the effects of abnormal development, injury, inflammations and new growths on bones, joints, muscles and tendons. The seventh chapter discusses the same influence on the nervous system. The final chapter deals with those acquired deformities which are the price the body has had to pay for survival after its struggle against an unfriendly environment. This book is of value to the medical student and general practitioner.

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**A LIST OF BOOKS AND PAMPHLETS ON THE HISTORY OF SURGERY AND ORTHOPEDIC SURGERY WITH SUPPLEMENT, ADDITIONS AND CORRECTIONS.** The collection of Dr. H. Winnett Orr, M.D. Second edition. Cardboard. Pp. 207, with illustrations. Lincoln, Nebraska: The Author, 1945.

As physical medicine has been called in England medical orthopedics the history of orthopedic surgery in many instances is of great interest to historians of physical medicine. There are 93 full page reprints of the title pages of books of historical interest such as "A Manual of Treatment by Massage and Methodical Muscle Exercise," by Joseph Schrieber, M.D., 1887, and "The Treatment of Lateral Curvature of the Spine with Appendix," giving an analysis of 1,000 consecutive cases treated by posture and exercise exclusively without mechanical supports, London, 1899.

Dr. Orr lists many books of interest to physicians specializing in physical medicine as "Physiotherapie-Kinesiotherapie," by Paul Carnot, Paris, 1909; "Case Book of Affections Cured by the Electro-Chemical Bath," by Jean Caplin, London, 1860; "Turkish Bath Handbook," by George F. Adams, St. Louis, Mo. 1881; "Treatise on Baths," by John Bell, Philadelphia, 1850 and Sebastian Knepp "My Water Cure," Bavaria, 1897. This list and the illustrations will interest everyone who reads medical history.



# PHYSICAL MEDICINE ABSTRACTS

## Physiologic Effects of Carbon Dioxide Water Baths on Alveolar Carbon Dioxide Tension, Skin Temperature and Respiratory Metabolism. W. S. McClellan; M.A. Lessler, and Alice T. Doulin

Am. Heart J. 29:44 (Jan.) 1945.

McClellan and his co-workers report observations on changes which occur in the alveolar carbon dioxide tension, the skin temperature and the respiratory metabolism of human subjects who have been submerged in baths of either carbon dioxide water or plain water. The alveolar carbon dioxide tension showed a .5 to 10 per cent rise during baths in the carbon dioxide water and returned to the resting level about twenty minutes after the bath. There was no significant change during baths in plain water. While there was no essential differences in the skin temperatures during carbon dioxide and plain water baths, when bath temperatures were between 85 and 90 F. the skin temperature was from 0.9 to 1.8 F. higher in carbon dioxide than in plain water when the baths were between 95 and 100 F. A hyperemia was noted over the immersed area of the skin when the patients emerged from the carbon dioxide water baths. This was noted at all the temperatures used and was not present when the subject emerged from the plain water baths. There was a considerable increase in the elimination of carbon dioxide in the expired air during the time the patient was in the mineral water bath. There was an increase in the respiratory minute volume during the mineral water bath which did not occur with the plain water bath. The evidence supports the theory that this extra carbon dioxide is obtained by absorption of the carbon dioxide in the water through the skin and its subsequent elimination through the lungs. The authors point out that justification for the use of mineral water baths containing carbon dioxide in the program of treating disorders of the heart and circulation has frequently been questioned by thoughtful physicians who say that the results are entirely due to mental and psychologic factors. The authors think that the data presented in this communication show that they have definite physiologic effect.—[Abst. J. A. M. A. 127:1077 (April 21) 1945.]

## Medical Service, the First Step to Rehabilitation. Walter J. Zeiter.

Ohio State M. J. 41:329 (April) 1945.

The physician should compare the actual progress with the expected improvement and adjust the program when necessary. When a long-range program is outlined, the patient should be returned to the referring physician from time to time so that he may also observe the progress.

Physical therapy is given by a trained technician under the direction of a physician, in many instances a physician trained in physical medicine.

Frequently a combination of physical and occupational therapy is more effective than the use of physical measures alone. When indicated, occupational therapy should be started early.

All tasks in occupational therapy should be simple so that the patient does not spend too much time in learning them, and so that the task may be easily analyzed by both the patient and the occupational therapist to determine whether the desired motion is being made. There should always be a specific goal to the task being performed, and it should not be justified on the grounds of making the patient happy or keeping him amused.

## Evaluation of the Results of Treatment in Infantile Paralysis. Rustin McIntosh; Carl E. Badgley; Ralph K. Ghormley; Don W. Gudakunst; Andrew C. Icy; Howard T. Karsner; Roger I. Lee, and Henry R. Vietz.

J. A. M. A. 128:21 (May 5) 1945.

A second requisite for the fair comparison of two forms of treatment is equal sampling of cases. In this respect poliomyelitis affords unusual difficulty. A patient who is totally incapacitated at the height of his infection may recover so rapidly that within a few weeks no appreciable residuum persists. Injustice is done when one investigator, including in his series a number of early cases, claims credit for his results when compared with those of another investigator whose series comprises only cases showing residual paralysis two weeks or more after onset.

The committee desires to put itself on record as being strongly in favor of the adoption in the field of the alternate case method, particularly the alternate paired case method, with age, severity of the attack and extent of paralysis being taken into account whenever any method of treatment is to be appraised.

It is therefore recommended that emphasis be placed on standardization of a scheme of muscle evaluation which can be widely applied by adequately trained physical therapists, by orthopedists or by any physician willing to take the necessary training in the technic of the test. For the purpose of recording residual paralysis, common usage has demonstrated the resistance tests with and against gravity to be the most practicable. There is unanimity of use but diversity of nomenclature. The following terms are recommended as a standard to produce uniformity, and the following symbols are advised as a standard unit expression of muscle strength:

5 = N = Normal = No apparent deficiency.

4 = G = Good = Approximates normal but fatigues more readily.

3 = F = Fair = Where part can perform function against gravity but is definitely weak.

2 = P = Poor = Where muscle is so weakened that it cannot perform its function against gravity but with removal of gravity can function.

1 = T = Trace = Where there is slight contractility of the muscle.

0 = 0 = Zero = No evidence of contractility of muscle fibers.

#### Air Fresheners.

Edit. J. A. M. A. 127:990 (April 14) 1945.

The American Medical Association's Committee to Study Air Conditioning in a recent preliminary report of the Board of Trustees, not yet published, makes this statement: "Air provided by air conditioning systems may be deodorized, properly humidified or dehumidified, moved at rates suitable for human comfort and altogether may promote human comfort, but there still remains an artificial quality. Early future developments may bring the air of the country hilltop into the cocktail lounge, but, as labeled by the committee charged with the responsibility of watching such development, such air not yet has arrived."

#### The Clinical Management of Weakness and Fatigue. Frank N. Allan.

J. A. M. A. 127:960 (April 14) 1945.

In a study recently reported elsewhere an analysis was made of the findings in 300 cases in which examination was requested because of a complaint of weakness, fatigue or weak spells. Physical disorders were found to explain the complaint in 20 per cent; nervous conditions were held responsible in 80 per cent.

Physical disorders of twenty-four types were encountered. The most common conditions were chronic infections, diabetes, heart disease, severe anemia, nephritis and various neurologic disorders including narcolepsy and myasthenia gravis.

Of the 239 patients whose weakness and fatigue were attributed to a nervous condition, the patient was considered neurotic in less than 1 out of 5. A small number (6 in all) had simple mental depression. The majority were suffering from what may be termed "benign nervousness." This was classified as chronic nervous exhaustion when severe and prolonged and as nervous fatigue when mild. Although no sharp line divides the three groups, it is important, as will be pointed out later, to make a distinction in order to plan the most effective treatment and evaluate the prognosis.

For many of the physical disorders, treatment which is more or less specific is available. For a nervous patient, removal of a cause of worry is also a specific remedy. As with the physical disorders, the nervous conditions require proper classification to guide treatment and indicate prognosis. A psychoneurosis was present in less than 1 in 5. A small number had a simple mental depression. The majority had a benign nerv-

ous condition classified as chronic nervous exhaustion when extreme and prolonged, and as nervous fatigue when of lesser degree. With each type a different therapeutic approach must be employed.

Psychotherapy and nonspecific measures must be adapted to suit the needs of the individual case. Special psychiatric care is desirable in dealing with many of the cases of psychoneurosis, some of the cases of mental depression and a few of the cases of chronic nervous exhaustion. Most of the benign nervous conditions do not properly fall within the field of psychiatry. They represent a challenge to all of us engaged in the practice of medicine.

#### Bactericidal Lamp Conjunctivitis. Roland Rooks.

J. Iowa M. Soc. 35:141 (April) 1945.

The Council on Physical Therapy of the American Medical Association has accepted certain ultraviolet lamps for disinfecting purposes. This acceptance is "limited to ultraviolet disinfecting lamps designed for installation in hospital nurseries, hospital wards and operating rooms."

A member of the staff tested the output of a lamp emitting rays of 2,537 angstroms, the meter used being a tantalum photocell which clicks once for each exposure of 200 microwatt seconds per square centimeter. During this measurement his eyes were carefully protected against the direct rays of the lamp. He had previously suffered three attacks of conjunctivitis due to careless exposure to direct rays. In order to ascertain whether reflected rays would cause these symptoms, he deliberately exposed his eyes to such rays as might be coming from the lamp's reflector. The measured dosage of these reflected rays to which he subjected himself was fifteen clicks, as defined above. The distance of his eyes from the reflector was eighteen inches and the duration of exposure was seven minutes. That night, some twelve hours later, he was awakened from sleep by the symptoms of a moderately severe conjunctivitis characterized by pain, lacrimation, photophobia and the sensation of "sand in the eyes." This subsided within a few hours but was distressing during the acute stage. He was unwilling to repeat the experiment to ascertain whether a lower dosage would cause symptoms.

Taking an exposure of fifteen clicks as a basis, additional readings were made to find whether this dosage could result from lamps improperly installed. It was found that at a distance of five feet from the lamp, the rays from the reflector attained a dosage of fifteen clicks in three and one-half hours. This means that with the lamp installed seven feet above the floor, a person lying on a nearby bed with eyes unprotected against the lamp's reflector for several hours could receive a dosage of this amount. This may be of importance in nurseries, since babies may watch the reflector unless completely shielded from it. Walls, especially hard-surfaced walls, do reflect appreciable amounts of these rays. The rays definitely are reflected from concrete floors. Con-



trol of the distance over which the reflected light must travel affords a safeguard. By aiming all direct and reflected rays toward a ceiling of soft finish, it should be possible to control the distance and thus to avoid significant dosages of rays reflected therefrom. However, it would appear difficult safely to irradiate the floors in occupied rooms because of the reflected rays.

#### **Calcification of the Tendon Cuff of the Shoulder. M. Beckett Howorth.**

*Surg., Gynec. & Obst.* 80:343 (April) 1945.

Pain and spasm may be relieved in some cases, especially the acute ones of short duration, by any one of several treatments. Heat, in the form of a lamp, hot water bag, electric pad, or hot packs, may provide some relief. Short or long wave diathermy may relieve some shoulders, and may even be followed by absorption of the calcareous material in the early acute ones. However, an acute shoulder, with inflammation of the bursa, or tension in the tendon, is often made worse by heat. Cold is usually more comforting than heat, especially in the acute cases. Ice packs may be used, but the ethyl chloride spray is usually more effective. Massage of the bursal region is likely to increase the pain in most cases, though gentle massage of the adjacent muscles may be used to maintain muscle tone. Manipulation or stretching usually increases pain and spasm and often does more harm than good. Exercises are of great value and are the most important of the various physical therapeutic measures. The pendulum exercises are the simplest, easiest, and least painful; they should be done with the arm in flexion and hanging loosely, i. e., with the trunk flexed, or with the subject lying prone on a table with the arm over the side. Aspiration, irrigation, or puncture of the calcified area may give relief, chiefly by the release of tension.

#### **Active Motion by Means of Occupational Therapy in the Treatment of Fractures. Lester Breidenbach, and Elizabeth Jamison.**

*Surg., Gynec. & Obst.* 80:365 (April) 1945.

Occupational functional therapy is a distinct help in the treatment of injuries to the extremities. It rehabilitates the patient in the shortest possible time. By means of the arthrometer and proper charting, progress becomes an accurate measurement rather than a guess. Treatment is continuous and is carried out at the occupational clinic and at home. Return to normal function is shortened in fractures of the extremities. An accurate chart of all joint ranges is appended.

#### **Tests of Physical Efficiency and Fitness. W. S. Tegner.**

*Brit. J. Phys. Med.* 8:40 (March-April) 1945.

Efficiency and fitness have different meanings, but when qualified by the word, physical, these become closely approximated. The qualifying adjective, physical, is regarded in current usage

as denoting the type of efficiency or fitness which is required for the purposeful expenditure of bodily energy, not merely of individual muscles or muscle groups but of the body as a physiologic whole.

There is no simple physiologic test of fitness; too many systems, such as the cardiac, the respiratory and the nervous, each have their part to play in the production of the whole. The picture is further complicated by the part played by psychologic factors which can invalidate any test. It is simpler to test by field performance, in which the results obtained are an estimate of the performance that is going to be put up under the conditions for which training is being undertaken, and are not a more theoretic figure which is alleged to be an index of fitness. For practical reasons field performance tests, with their simplicity, ease of application and pertinence to the type of fitness required, have been generally adopted.

The meanings of the terms, physical fitness and physical efficiency, are discussed. The history of tests of efficiency is briefly given. Physiologic laboratory tests of physical fitness are described and discussed.

Field performance tests of physical fitness are discussed. The part played in each type of test by psychologic factors is stressed. Their importance is such that they can invalidate the results of tests, particularly laboratory tests.

#### **The Function of the Patella and the Effects of Its Excision. Herbert Haxton.**

*Surg., Gynec. & Obst.* 80:395 (April) 1945.

The patella is a sesamoid bone developed in and lying in the line of the extensor tendon of the knee. Its phylogenetic and ontogenetic development indicate it probably has a function. Experimental work shows that the patella improves the efficiency of knee extension in the more important extended positions of the knee joint by holding the patellar tendon away from the axis and thereby increasing the extending moment of the quadriceps pull. Clinical investigations confirm the experimental findings. Patellectomy is justifiable in patello-femoral osteoarthritis.

#### **Osteoarthritis of the Spine. Ernest Fletcher.**

*Brit. J. Phys. Med.* 8:51 (March-April) 1945.

The diagnosis of osteoarthritis of the spine is made frequently, but it is not the commonest of the medical locomotor disorders. In 1,500 carefully recorded cases of chronic rheumatism it occurred 84 times, 37 times in males and 47 times in females. This compares with 377 cases of infective arthritis in the same series, which also included 90 cases of ankylosing spondylitis. The average age at the time of onset was 55 years. The average duration of symptoms at the time of diagnosis was 23.6 months.

Anatomical evidence has been produced to show that osteophytic formation occurs in the short intervertebral ligaments and that this lesion



has a certain incidence in the spine. Osteoarthritis of the apophyseal joints and its incidence is also discussed.

Clinical evidence is adduced which suggests that polyspondylitis does produce symptoms, although some workers maintain that it does not. The symptoms of osteoarthritis of the spine are described, together with the physical signs. An attempt is made to correlate the clinical and anatomical findings. The radiographic viewpoint is considered and its difficulties are mentioned. No attempt is made to assess treatment.

#### **Postpartum Massage of Deep Pelvic Muscles.**

Corres. J. A. M. A. 127:945 (April 7) 1945.

After delivery, there are vague sacroiliac and sacrococcygeal pains. Palpation of the deep pelvic muscles will reveal them to be spastic and painful. The trauma incident to delivery is the most likely explanation. Massage of these muscles by rectum with the patient in the lithotomy position usually gives gratifying relief. Particularly so is this if there has been undue displacement of the coccyx.

Massage at first should be light and of short duration, progressively increasing the pressure and length of time of treatment as the spasticity of the muscles relaxes. Similar pain in the non-puerperal woman has also sometimes yielded to this therapy.

#### **Low Temperature Therapy for Preservation of Limbs. Isidor Kross.**

J. A. M. A. 128:201 (May 5) 1945.

A case report is published. It is one in which refrigeration or low temperature treatment was employed for the longest period of time on record, with the successful preservation of a limb that under ordinary circumstances would have been amputated. It also shows the necessity of continuing with the treatment until the infection is fully and completely overcome.

#### **Ischemic Nerve Lesions Occurring in Volkmann's Contracture. W. Holmes; W. B. Highet, and H. J. Seddon.**

Brit. J. Surg. 32:259 (Oct.) 1944.

Holmes and his associates report 6 cases of established Volkmann's contracture. These cases were subjected to full clinical and operative investigation, and specimens of muscle and nerve were removed for microscopic examination. The nerves showed an unusual type of pathologic change which is believed to be due to ischemia and the characteristics of which have a direct bearing on the prospect of recovery. In every case the upper limb was affected. In 5 of the 6 cases damage to the main artery of the limb was demonstrated at the level of the initial injury. In all cases there was extensive motor and sensory paralysis, but in only 2 of them was there

evidence of direct traumatic injury to the main nerve-trunk. In 1 of the cases the median nerve was constricted between the two heads of the pronator teres, but in no other was there any evidence of compression of nerves by contracture of muscle or involvement in scar tissue. Microscopic examination demonstrated destruction of axons and myelin sheaths as in uncomplicated wallerian degeneration. In the more severely affected nerves there had been a great increase in the collagen of the endoneurium, sometimes leading to complete collagenous replacement of the nerve bundle. In 1 case the nerve was entirely necrotic. These changes are due to ischemia. Sensory and motor recovery has been of poor quality because of the irreversible nature of severe degeneration. There is no effective treatment for established ischemic nerve degeneration. —[Abst. J. A. M. A. 127:1156 (April 28) 1945.]

#### **Phantom Limb Pain: Its Relation to the Treatment of Large Nerves at Time of Amputation. L. G. Herrmann, and E. W. Gibbs.**

Am. J. Surg. 67:168 (Feb.) 1945.

Herrmann and Gibbs studied the phantom limb pain with the primary object of preventing irritation of the afferent pathways in the mixed nerves of the extremity at the time of amputation and during the immediate postoperative period by preventing abnormal scar tissue formation or the formation of neuromas at the site of division of the large nerve trunks. From January, 1937 to January, 1944 they performed 238 major amputations at the Cincinnati General Hospital and the Christian R. Holmes Hospital of the University of Cincinnati. The large nerve trunks were ligated with nonabsorbable material at a point about 1 inch above the site of amputation. The nerves were never crushed before the ligation was applied. The incidence of phantom limb pain in their series of 120 patients who were adequately studied after a major amputation was only 5.8 per cent. The analysis of the clinical data presented in this study indicates that the treatment of the large nerves at the time of amputation is of considerable importance in preventing the occurrence of phantom limb pain. —[Abst. J. A. M. A. 127:1150 (April 28) 1945.]

#### **The Effects of Inhaled Heat on the Air Passages and Lungs. An Experimental Investigation. Alan R. Moritz; Frederick C. Henriques, and Regina McLean.**

Am. J. Path. 21:325 (March) 1945.

In experiments on dogs it was observed that only when the original temperature of the air was high enough to produce almost instantaneous burning of the skin and upper respiratory mucosa was there sufficient residual heat in the air reaching the lungs to cause pulmonary injury.